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THE HECKSCHER-OHLIN THEOREM

by

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The undersigned certify that they have read and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "The Heckscher-Ohlin Theorem", submitted by Maya Mangesh Murdeshwar, in partial fulfilment of the requirements for the degree of Master of Arts.

ABSTRACT

The Heckscher-Ohlin theory explains the existence and structure of trade in terms of differences in factor endowments. It states - somewhat loosely - that countries tend to export commodities which use a large proportion of their relatively abundant factor. This theory deserves a place at the centre of international trade theory as for the first time it has integrated trade theory with the theory of price and distribution. Much of the impact of this theory is in the "factor prices" field, culminating in the "factor price equalisation" corollary. This corollary states that under certain assumptions commodity trade leads to complete factor price equalisation in the trading countries, thereby making factor movements superfluous.

Many economists have tested this theory empirically. The findings of Wassily Leontief have proved to be very interesting. They seem to contradict the Heckscher-Ohlin theory. However, the evidence of the investigations in the field so far does not seem to be conclusive on either side.

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CHAPTER I

INTRODUCTION

The topic of this thesis is the pure theory of international trade as developed by Heckscher and Ohlin. In constructing a body of international trade theory, the first step must be to show why trade takes place at all, as a voluntary activity of both sides.[1] Economists are also interested in finding out what determines the structure of trade. The Heckscher-Ohlin theory explains the existence and structure of trade in terms of differences in factor endowments. It states — somewhat loosely — that countries relatively well endowed with a particular resource will tend to export primarily commodities which, in their productive processes, use a large proportion of that resource.[2]

The Heckscher-Ohlin theory deserves a place at the centre of international trade theory as, for the first time, it provided an integration of trade theory with the theory of price and distribution. Much of the impact of the Heckscher-Ohlin theory is in the "factor prices" field, culminating in the "factor price equalisation" corollary. This corollary states the effect of commodity trade on factor prices and brings out clearly the assumptions under which commodity trade leads to complete factor price equalisation in the trading countries, thereby making factor movements superfluous. The remainder of this chapter outlines the plan of the thesis.

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[1] Kelvin Lancaster, "The Heckscher-Ohlin Trade Model: A Geometric Treatment", Economica, New Series, XXIV (February, 1957), p. 20.

[2] Jaroslav Vanek, International Trade: Theory and Economic Policy (Homewood, Illinois: Richard D. Irwin, Inc., 1962), p. 181.

To begin with, in Chapter II, the approaches of Heckscher and Ohlin to the theory jointly named after them are dealt with separately to bring out the differences in them. However, as the differences are found to be not substantial they are subsequently ignored. The theory is then presented as one Heckscher-Ohlin theory. Most of the references are from Ohlin's book[1] as he has provided the more elaborate version.

As the Heckscher-Ohlin model is continually being developed by various economists to date, the majority of whom have used the geometrical technique for doing so, the model has become quite different in this recent version from what was originally developed by Heckscher and Ohlin. This creates problems. Some of the criticisms which apply to the recent version of the model do not apply to the original version. In view of this problem, the two versions of the model are dealt with separately. The second chapter describes the Heckscher-Ohlin model in its original form. The third chapter describes the recent version developed by Samuelson and others. It is pointed out in the second chapter that the original version of the theory, developed by Ohlin, lacks satisfactory rigour. The concept of factor abundance as given by Ohlin is ambiguous.

The two concepts of factor abundance are brought out clearly in Chapter III and the Heckscher-Ohlin theorem is demonstrated for both the concepts. The difference in the assumptions needed to prove the

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[1] Bertil Ohlin, Interregional and International Trade (Cambridge: Harvard University Press, 1933.)

theorem in the two cases is also brought out. To begin with in Chapter III it is assumed that the factor intensities are consistent - i.e., a commodity is relatively intensive in one factor at all sets of factor prices. Interesting results follow as this assumption is relaxed. However, only the simple case is dealt with in the third chapter. The complicated and more interesting one is dealt with in the latter part of the fourth chapter. Chapter III thus surveys the basic Heckscher-Ohlin theory with the help of the geometrical technique. This paves the way for a consideration of the effects of commodity trade on factor prices, a corollary of the Heckscher-Ohlin theorem.

Chapter IV starts with this factor price equalisation corollary of the Heckscher-Ohlin theorem. First, the process of factor price equalisation is traced diagrammatically. Later, the assumptions under which the factor price equalisation is complete are brought out explicitly.

In Chapter V some of the empirical findings on the Heckscher-Ohlin theory are dealt with. Although many economists have tested the theory empirically, only the findings of Wassily Leontief are dealt with in the chapter as they have proved to be the most interesting. The results of some of the other investigations are mentioned. Leontief's findings seem to go against the Heckscher-Ohlin theory. His result shows that an average million dollars' worth of U.S. exports embodies considerably less capital and somewhat more labour than would be required to replace from domestic production an equivalent amount of the U.S. competitive imports. Various economists have put forth arguments to explain this unexpected result and these arguments are examined in the chapter.

In the last chapter, some general observations are made about the Heckscher-Ohlin theory and about some of the merits and demerits of its recent version in comparison with its original version.

CHAPTER II

THE ORIGINAL HECKSCHER-OHLIN THEOREM

The Heckscher-Ohlin theory as developed originally by Heckscher and Ohlin is dealt with in this chapter. Heckscher published his paper[1] in 1919. Ohlin, his pupil, published his book[2] in 1933. Ohlin borrowed a good many ideas from Heckscher, but also modified and added so much to Heckscher that the latter felt it unnecessary to publish his article in English after Ohlin's book was published. Heckscher's contribution stands in its own right as it preceded that of Ohlin and as there were very few changes introduced in the main hypothesis and the factor price equalisation corollary by Ohlin.

The major difference between Heckscher's approach and that of Ohlin is the fact that Heckscher accepts the Ricardian principle of comparative costs as a valid explanation of the occurrence of gainful trade. Heckscher just wants to go beyond it and examine what makes the comparative costs in the two countries different. Thus, he regards his analysis as merely an extension of Ricardo's.

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[1] "Utrikeshandelns Verkan pa Inkomstfordelningen", Ekonomisk Tidskrift, (1919), translation in English, "The Effect of Foreign Trade on the Distribution of Income" reprinted in Readings in the Theory of International Trade, A.E.A. (Philadelphia: Blakiston, 1949).

[2] Bertil Ohlin, Interregional and International Trade (Cambridge: Harvard University Press, 1933).

Ohlin does not share this view. Unlike Heckscher, Ohlin thinks it impossible to fit his theory into the mould of classical labour value theory. Ohlin's theory emerges from two main considerations.[1] Before Ohlin, the classical labour theory of value was found unsatisfactory and was replaced by the mutual interdependence theory of Walras, Menger, Jevons, Pareto and others.[2] But the pure theory of international trade still rested on comparative costs and continued to be classical. Ohlin thought the classical theory should also be given up in the field of international trade and replaced by the mutual interdependence theory.[3]

Ohlin also wants to demonstrate that the theory of international trade is only a part of a general theory of location.[4] He therefore wants to formulate certain fundamentals of a general location theory as a background for a theory of international trade.[5] Economic theory had given very little attention to location problems before Ohlin did so.

Within the classical framework, the general theory of pricing was almost exclusively a one-market theory.[6] The space element was dealt with only in the theory of rent.[7] With the assumption of one

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1 Ohlin, op. cit., p. vii.

2 Ibid.

3 Ibid.

4 Ibid.

5 Ibid.

6 Ibid., p. 4.

7 Ibid., pp. 3, 4.

market, the only relevant data is the total supply of the factors of production, and not their distribution over a given area.[1] The problem of location of industry therefore never arises at all.[2] As some of the factors are completely immobile (like "weather"), a "general analysis of the space aspects of the price mechanism"[3] is very essential. Ohlin wrote his book to provide this essential elaboration of value theory for the consideration of geographical and territorial aspects of the price mechanism.

Thus, Ohlin wants to replace classical labour value theory in the field of international trade by building a theory in harmony with the mutual interdependence theory of pricing. Why does he want to replace the classical comparative cost theory? Because he finds it unsatisfactory. To quote:

> The doctrine of comparative costs as presented by Ricardo and Mill is unsatisfactory, not only because the scale of labour costs is built upon extreme simplifications, which cannot be abandoned without bringing down the whole fabric, but also because it neglects the influence of demand conditions on these scales themselves. The mutual interdependence is lost sight of.[4]

As far as the first half of the criticism is concerned, one has to be in complete agreement with the fact that the assumption of

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1 Ibid., p. 4.

2 Ibid.

3 Ibid.

4 Ibid., p. 23.

a single factor of production is an extreme simplification in the Ricardian model. It is also evident that the structure of the labour theory of value from which this theory emerged is outdated. It is not essential to go into the detail of examining the merits and demerits of the labour theory of value. However, the statement that "mutual interdependence is lost sight of" is perhaps too severe, for it is easy to reconcile Ricardo's theory with modern price theory by showing it as a simple special case. To prove this, it is essential to examine in brief the Ricardian principle of comparative cost (or advantage).

Ricardo begins his account with a statement of absolute advantage; he states that it is advantageous for everyone if every country produces the commodities for which it is best adapted by its situation, climate, etc. and exchanges them for the commodities of other countries.[1] Next comes the statement of the "Principle of comparative advantage". Trade, he claims might take place to the advantage of both trading partners, even when one of the pair was more efficient in the production of both commodities exchanged. Ricardo's demonstration is one of the enduring illustrations of the subjects. (It has been paraphrased by so many authors that it is better to quote from the original.)

> The quantity of wine which she (Portugal) shall give in exchange for the cloth of England is not determined by the respective quantities of labour devoted to the production of each, as it would be if both commodities were manufactured in England, or both in Portugal.

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[1] David Ricardo, The Principles of Political Economy and Taxation ("Everyman's Library", No. 590; London: J. M. Dent and Sons, 1911), p. 80.

> England may be so circumstanced that to produce the cloth may require the labour of 100 men for one year; and if she attempted to make the wine, it might require the labour of 120 men for the same.
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> .....
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> To produce the wine in Portugal might require only the labour of 80 men for one year, and to produce the cloth in the same country might require the labour of 90 men for the same time. It would therefore be advantageous for her to export wine in exchange for cloth. This exchange might even take place notwithstanding that the commodity imported by Portugal could be produced there with less labour than in England. [Italics mine.] Though she could make the cloth with the labour of 90 men, she would import it from a country where it required the labour of 100 men to produce it, because it would be advantageous to her rather to employ her capital in the production of wine, for which she would obtain more cloth from England, than she could produce by diverting a portion of her capital from the cultivation of vines to the manufacture of cloth.[1]

England is likewise benefited by this trade. Through international exchange she is able to obtain wine in return for cloth which requires the labour of 100 men. Otherwise, if this wine were made in England, it would require the work of 20 extra men.[2] Thus Ricardo has attributed the sole cause of emergence of profitable trade, to the difference in comparative costs. According to Ohlin, as trade will be profitable for countries only if pre-trade relative prices of commodities differ and as these pre-trade commodity prices depend upon the interaction of demand and supply, in attributing the sole cause to costs which affect the prices only through their effect on supply, Ricardo has neglected the influence of demand.

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[1] Ibid., p. 82.

[2] Ibid., pp. 82, 83.

However, with the assumptions of the Ricardian model of one factor, two commodities and constant returns to scale (in each activity), the above mentioned criticism is too severe, for demand in this situation has no influence on pre-trade relative prices.

The question of variable returns to changing factor proportions does not arise in this model, because only one factor is assumed.[1] This assumption of one factor then rules out the u-shaped cost curves. The average cost (and the marginal cost) curve will be a horizontal line parallel to the x-axis. The assumption of constant returns to scale, together with the assumption of one factor thus rules out the influence of demand on price. (It must be noted that with horizontal cost curves for each firm, the number of firms in an industry is indeterminate, but for price to equal cost we must assume that perfect competition prevails.)

The influence of demand in the determination of the price of the factor is also of no consequence as we have to take into account only the relative cost of production. If the relative cost of producing commodity A is two-thirds of that of producing commodity B , it will be unaffected even if the price of the factor changes, because of a change either in demand or in supply, as there is only one factor. With only one factor of production, any change in its price will affect the cost of producing the two commodities proportionally, so as to keep the relative cost constant.

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[1] S. Mookerji, Factor Endowments and International Trade (New Delhi: Asia Publishing House, 1958), p. 4.

Thus, the Ricardian theorem logically follows from the assumptions. As it emphasizes the different production functions for the same commodity in the two countries, which are explicitly assumed to be the same by Ohlin, the two theories can exist side by side. As pointed out later on, however, this difference further narrows down when we consider the thorny issue of defining production functions on the one hand and the factor of production on the other.

Although the Ricardian theory of comparative advantage as seen above is logically consistent, the assumption of one factor is quite restrictive. When we try to introduce another factor, the Ricardian assumptions no longer suffice. We have to introduce factor endowments and the assumptions of the Heckscher-Ohlin model which will be examined presently.

As Ohlin's criticism of Ricardo does not hold, the gap between Heckscher's and his own approaches to the theory narrows considerably. As for the main hypothesis, there is no notable difference between Heckscher and Ohlin, so that it would not be unjustified to consider either work. Henceforth we will be considering Ohlin's work most of the time, as it is more complete.

In comparison with the recent version of the Heckscher-Ohlin model, as developed by Samuelson and others, which is geometrical and precise, the original model as developed by Ohlin is very discursive and somewhat vague. Ohlin tries to be theoretical and realistic alternately. To begin with, for a theoretical proof Ohlin will list all the assumptions necessary for a certain result to follow. However, he will

also observe at the same time that as the reality does not conform to these assumptions, the results that will occur in reality will be considerably modified.

In the recent version of the model we are certain that we are dealing with a purely theoretical world and are trying to make a certain model "theoretically perfect". The frequent flights to reality and back to theory are completely absent.

The advantage of Ohlin's method is that we are never divorced completely from the realities of the world. We can visualize the practical situations in the real world that are explained with the help of the theory. It is a rough and ready way of testing the theory while forming it. This method helps the formulation of better theories as they are constantly applied to the situations of the real world and modified accordingly. At the same time, this rough and non-technical way of doing it makes the theory as well as its application far from perfect, as will be seen later in this chapter. Consider the following illustration. When Ohlin[1] points out that in a sparsely populated country, land as a factor of production will be relatively cheap and that there is no particular reason why people in that country should demand more wheat (requiring much land and little labour) so as to make land expensive, one immediately thinks of a country like Canada. But, in contrast to the example cited above, when we examine (in the recent version of the model), for instance, the implications of a function

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[1] B. Ohlin, op. cit., p. 16.

being homogeneous of the first degree, we are in a world of our own, far away from the realities of the actual world.

Now to come to Ohlin's analysis: Ohlin starts it with what he terms "regions". A district must fulfill two conditions to become a region.[1] (1) It should be different from the other districts[2] and (2) the difference between its component areas should be smaller than those between the regions themselves.[3]

With regard to factors of production these conditions would mean that (1) the districts should have different factor endowments and (2) there should be a certain uniformity as to this endowment within each district.[4] The assumptions are as follows: The factors are (1) interregionally immobile, but (2) intraregionally freely mobile.[5]

Before proceeding further Ohlin groups the causes of trade under two headings. Trade is cause by (1) different factor endowment and (2) economies of large-scale production. Thus, Ohlin recognizes economies of scale as a major cause of the occurrence of trade but chooses to consider the former first.

Trade occurs, because with their different factor endowment, different regions are suitable for producing different commodities. If one region has an ample supply of iron ore and coal and another region

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1 Ibid., p. 9.

2 Ibid.

3 Ibid.

4 Ibid.

5 Ibid., p. 10.

has plenty of wheat lands, the former is adapted better to iron production and less well to wheat growing than the latter.[1] It is the factor endowment in a region which determines its fitness for specific industries.[2] A region cannot produce goods requiring factors of production which do not exist in that region.[3] This is the extreme situation. Many important differences in the factor endowment are, of course, not of this type. Even if each region has all factors, some of the regions may have relatively more of certain factors needed for the production of a certain good. These regions would naturally have an advantage in the production of that good.

But these are just general observations. The immediate cause of trade is always that some goods can be bought more cheaply from outside in terms of money than they can be produced at home.[4] It remains, therefore, to be shown why, as a result of the varying factor endowments, some goods can be produced more cheaply in one region than in another. In other words, the real problem is to demonstrate what lies behind such inequality in prices, or, more precisely, to show in what way differences in factor endowment come to be expressed in differences in money costs and prices.[5]

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1 Ibid., p. 11.

2 Ibid.

3 Ibid.

4 Ibid., pp. 12, 13.

5 Ibid., p. 13.

The starting point in Ohlin as examined above is the inequality of prices in the two regions.[1] The statement in terms of price comes to very much the same thing as a reasoning in terms of "opportunity costs". The real cost of an amount of one commodity is expressed in terms of the amount of another commodity one would have to give up to produce it. This assumes, of course, that the production of all the other commodities is held constant. This comes to the same thing as reckoning in prices, using one commodity as the monetary unit. Such a reasoning explains nothing unless connected with a mutual interdependence price system.

Continuing our analysis, let us for the sake of simplicity, assume only two regions, each having a free paper currency. There are no economic transactions between the two regions except the import and export of goods. Capital movements, etc., are assumed away.

Under these conditions, imports will have to be paid for by exports. If one region produces all its goods more cheaply than another, the price of its currency will rise because of its trade surplus. Thus it is impossible for this region to continue to produce all its goods at lower money prices than does the other region. If the pre-trade pattern of relative prices is identical in the two regions, the appreciation of the currency of the formerly low-price region will bring about equality between the regions of the absolute price of each commodity and no reason for further trade would exist. If the pre-trade pattern of relative prices is different between the regions, appreciation of the formerly low-price region's currency will make some of the other

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[1] Ibid., p. 14.

region's goods importable while some of the first region's goods remain exportable, and a basis of continuing two-way trade would exist.

Thus, inequality of the pre-trade relative prices is a necessary condition for trade to exist. The next logical step is to examine the circumstances under which such a situation would exist.

All prices of goods and factors are determined by the interaction of the forces of demand and supply. Behind demand lie the forces of (1) wants and tastes of consumers and (2) their income. Behind supply lie (1) the factor endowment and (2) the physical conditions of production.

According to Ohlin the physical conditions of production are the same everywhere. He mentions them as "the natural and unchanging properties of the physical world".[1] In other words, Ohlin takes it as apparent that production functions would be the same everywhere because the same causes always produce the same results. This raises the time honoured question of the distinction between the production functions and the factors of production. As pointed out by Haberler, the assumption of identical production functions (which is taken to be self-evident by Ohlin) is "anything but self-evident, for it implies not only identical knowledge, skills, and so forth, but also identical climates, physical and social conditions and so on".[2]

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[1] Ibid., p. 14

[2] G. Haberler. A Survey of International Trade Theory. 1st ed. revised. (Special Papers in International Economics, No. 1; Princeton University: International Finance Section, Department of Economics, July, 1960), p. 19.

If, however, all the factors mentioned by Haberler are explicitly termed as "factors of production", one could make the production functions identical everywhere, as done by Ohlin. The merit of doing so, of course, is highly doubtful when the following of Haberler's criticism is taken into account.

> If the concept of the production function is to be a useful tool of analysis, it cannot be identified with, or derived from, such unverifiable metaphysical propositions as 'the constancy of the laws of nature'. As Samuelson has suggested, the concept of the production function should be conceived in terms of well-defined variable (although not necessarily infinitesimally divisble) inputs, leaving milieu and climate (both social and physical), factors extra commescium, outside the function. By hypothesizing every conceivable circumstance which may affect output as a separate factor, the production function can, no doubt, be endowed with constancy, invariance, homogeneity, and what not, but at the price of emptying the theory of all empirical content and reducing it to a useless tautological system.[1]

In the light of the above criticism, the gulf existing between the factors stressed by Ricardo and those stressed by Ohlin (the former attributes to differences in the production functions the occurrence of trade while the latter postulates the identity of production functions and emphasizes instead, the factor endowments) narrows considerably. Now it can readily be seen that the differences between them are partly based on the problem of proper definitions of factors of production and production functions.

In the latter version of the Heckscher-Ohlin model the assumption of the identity of the production functions is maintained. As it

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[1] Ibid.

is almost impossible in practice to specify all the differences in the factor endowments (such as social and climatic conditions mentioned above) the assumption of identical production functions becomes unrealistic for the purposes of empirical testing. We will examine this aspect more thoroughly later while dealing with the empirical findings on the subject.

With the assumption of identical production functions the only relevant factor remaining on the supply side is the factor endowments. Unless the factor endowment and the demand conditions are the same in the two regions, (say A and B) or a difference in the factor endowments is just balanced by an offsetting difference between the demand conditions, relative commodity prices would differ between A and B and trade would exist.[1]

It should be pointed out at this stage that as the production functions are identical in A and B , if the relative factor prices are the same, the relative commodity prices will also coincide in the two regions, as the factors will be combined in the same proportions in both regions for any industry.

At this stage in Ohlin's analysis comes the significant step. Up till now Ohlin stresses the fact that the determination of prices (factor as well as commodity) has to be explained in terms of the interaction of demand and supply. Now he argues for the importance of the influence of supply (in this case solely of factor endowment) over that of demand.

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[1] B. Ohlin, op. cit., p. 15.

However, he makes it quite clear that the factor endowments of the two regions under consideration have to be markedly dissimilar. He frequently qualifies his statement to allow for exceptions, where the influence of demand might be of greater importance than that of factor endowment. But at the same time he believes that as a rule the influence of factor endowment will be of greater importance in determining relative prices on which in turn will depend the emergence of trade. How does he justify this belief? His appeal is (as usual) to common sense and to illustrations from everyday life.

> There is no reason why demand in a scantily populated region should turn especially to goods requiring much land and little labour, say wheat, and thus prevent rent from being lower, relatively to wages, than in a densely populated region, where, as people cannot after all do without food, land is necessarily scarce.
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> As a matter of fact, little attention need be given to the theoretical possibility of two isolated regions having the same relative scarcity of factors of production and the same relative commodity prices in which case no interregional trade can arise. Unless there is in a given case some special reason for the reverse supposition, we are justified in assuming that conditions of factors and of demand are such that the relative scarcity would be different in the two regions in an isolated state, differences in supply being probably as a rule more important than differences in demand. In a loose sense we may say that the differences in equipment of factors of production are the cause of trade.[1]

Why did Ohlin think it fit to single out factor endowment as the factor causing trade? It is clear from the quotation that he takes human needs for food, shelter and the like to be similar. Can we infer from this that the tastes of people from different regions will be

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[1] Ibid., pp. 16, 17.

similar? As an argument supporting a hypothesis, at best, it is intuitive. As demonstrated in the next chapter, identity of tastes in the two countries together with unit income elasticity of demand for both the goods in the two countries constitutes a sufficient (though not a necessary) condition for the Heckscher-Ohlin trade result to follow.

This kind of precision and logical reasoning which is used in the recent version of the theory in arriving at the above mentioned condition (in the next chapter) is most essential to a theory. Ohlin's original version lacks this precision and thereby remains far from perfect. How can we explain this lack of certainty and precision?

It is partly due to the fact that Ohlin, an empirical scholar, tried to make his assumptions as realistic as possible. As a result the conclusions he could arrive at were, at best, approximate. If we want to arrive at unambiguous results, the assumptions have to be highly specific if need be. It is also due to the fact that great theories are not born perfect. They take time to get perfected.

However, this weakness of Ohlin's theory constitutes its strength as well. Ohlin tries to take into consideration all the relevant factors causing trade. For instance, he continuously mentions economies of scale as a factor as important as factor endowment in causing trade. Because of this, Ohlin's analysis gives one a rough idea of the complete picture of the factors causing trade and the relative importance of them. His strength lies in the fact that he does not lose sight of the whole picture. The cost of this, of course, was that his own theory remained far from perfect.

Now to return to the theory again. As we were considering the pre-trade prices, only the internal demand and supply of the region in question had to be taken into account. But with the opening of the trade the foreign demand is brought to bear upon the domestic factors and commodities and vice versa. The price system of Ohlin before trade opens up resembles closely that presented by Cassel for the one market theory. The price mechanism is always in equilibrium; for there is an instantaneous readjustment after any disturbances. Consequently the following six sets of relations hold true.[1]

(1) Quantity demanded for commodities is equal to quantity supplied.

(2) For producing a commodity, the technical coefficient of each factor is given if the technique is given. All factors are fully employed.

(3) The technical coefficients depend upon the physical conditions of production and prices of the factors.

(4) Commodity prices are equal to costs of production.

(5) Quantity demanded of commodities depends upon their prices and upon individual incomes and tastes.

(6) Incomes are governed by prices of factors and the conditions of ownership.

Given these conditions in the two regions before trade, foreign demand enters the picture after trade opens up. The existence of trade depends upon the pre-trade commodity prices and the rate of exchange. Each region will export the goods it can produce more cheaply than the other region and will import the rest.

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[1] The six conditions are summarized from B. Ohlin, op. cit., pp. 17, 18.

Assume that region A has a relatively large supply of a certain factor. Unless this inequality in supply is balanced or more than balanced by an inequality of demand, this factor will be relatively cheap here. As a result, the cost of production of commodities requiring large amounts of this factor will be comparatively low. The conclusions Ohlin arrives at are:

> Roughly speaking, abundant industrial agents are relatively cheap, scanty agents relatively dear, in each region. Commodities requiring for their production much of the former and little of the latter are exported in exchange for goods that call for factors in the opposite proportions. Thus, indirectly, factors in abundant supply are exported and factors in scanty supply are imported.[1]

Ohlin applies these conclusions arrived at in terms of his "regions" to countries. This needs modifications in some of the assumptions made earlier because they were "drastically simplified".[2] The supply of factors which was assumed to be given and fixed, need not be so, as it is constantly changing in reaction to the price changes.

The nature of trade is determined by the actual supply of the factors of production at a particular time. This actual supply, of course, is itself affected by the past trade. Some of the present trade, thus, can only be explained in terms of past trade. Can we, in such a situation, argue that it is the factor supply that causes the trade and not the trade that causes the factor supply to be what it is?

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[1] Ibid., p. 92.

[2] Ibid., p. 67.

One way of tackling this problem is to consider things at a certain point of time, which Ohlin calls a "snapshot"[1] of the situation. Then we can still say that the nature of trade is determined by the supply of factors at that time. This is not a completely satisfactory solution.

Ohlin suggests that each concrete case should be examined to determine how far supply (and demand) reactions necessitate a modification of conclusions reached without them. He gives an example of the development of German chemical export industry.[2] It is the result of the great supply of cheap intellectual labour of a certain quality. Here, the reaction of the supply of such labour is a matter of comparatively small importance. As long as the question we have in mind is the explanation of the growth of this special industry, we can say that the supply of cheap intellectual labour is one of the causes of the chemical industry and that this industry is not the cause of the rich supply of the intellectual labour. Thus, we will have to examine each case carefully to determine the relative importance of the factor supply on the one hand and the reactions in the factor supply on the other hand.

We can now conclude that the nature of the supply reaction to the change in price is a complicated question. If the facts of the case are not fully known, it is better to avoid making any generalizations. One could safely say, however, that the reaction of factor supply will vary with the length of the time under consideration. The effects of this reaction can be neglected if the period under consideration is

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1 Ibid., p. 129.

2 Ibid., pp. 130, 131.

a short one. It might be dominating if the time allowed for the reaction to work itself out is fairly long. As to the direction of the reaction, Ohlin feels that it will be positive - i.e., the higher the reward, the greater the supply of the factor concerned. This positive reaction will widen the differences in the factor endowment, which in turn will lead to an extension of trade.

He adds a qualification, with regard to the positive reaction. It is quite possible that trade could lead to a narrowing of international differences in respect to skill and training.

So far, we have not dealt with the fact that in different countries the number of factors is large and the difference in their quality can be very great. According to Ohlin the fact that the number of factors is large and that they can be further divided into sub-factors can be easily taken into account within the scope of the previous reasoning.[1]

One fact, however, deserves special mention in this connection. Many factors, particularly the sub-factors, perform similar tasks. In production, they compete with each other rather than co-operate. Hence, we must take into account the supply of all other sub-factors when considering one, because that will affect its price as much as its own supply will.

In many cases the price of a factor (and the cost of production) depends upon its quality also. In most cases, the qualitative differences

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[1] Ibid., p. 92.

form a minor element, so that they can be considered afterwards as a slight modification of the theory. One may object to this, by pointing to cases where the qualitative differences may be a decisive factor in trade. Few engineers in a particular country may possess a special technical knowledge whereby they can produce some goods more cheaply than the other countries (thus giving rise to trade). This technical know-how then can be treated as a separate sub-factor.

Ohlin's treatment of the subject does not end here. He further considers the effect of international movement of factors on trade. As this topic is not connected (directly) with the Heckscher-Ohlin theorem (wherein the factor movement is assumed away) it is not examined here.

CHAPTER III

THE RECENT VERSION OF THE HECKSCHER-OHLIN THEOREM

In this chapter we will deal with the Heckscher-Ohlin theorem in its recent version as developed by Samuelson and others who have employed the geometrical technique.

The Heckscher-Ohlin model in its geometrical form "is usually presented in terms of a two-factor, two-commodity, two-country model where both commodities are produced by each country and both factors are used to produce each commodity".[1] This very simple model is adopted because it is easily amenable to geometrical treatment.[2]

The assumptions of the model are as follows.

1. There is perfect competition both in the commodity and in the factor markets.[3]

2. The production functions for identical goods are the same in both the countries.

3. There are constant returns to scale in the production of both the commodities.

4. The commodities are such that they can be classified according to their relative factor intensity. To begin with, it is assumed that a commodity is relatively intensive in the same factor at all sets of factor prices.

5. There are no transport costs and no trade barriers of any kind. That is, there is free and costless trade.

6. There is no mobility of factors between the trading countries; but there is complete mobility of factors within each country.

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[1] S. Mookerji, Factor Endowments and International Trade (New Delhi: Asia Publishing House, 1962), p. 11.

[2] Ibid.

[3] Ibid.

7. The factors are of identical quality in the two countries and their supply is fixed.

8. There is full employment of factors.

It is essential to note at this stage that we will be concerned only with long-run situations.

Since we assume perfect competition all around, an equilibrium position in the production of the two commodities, say A and B, will be attained when the two factors, say labour and capital, have been allocated in the two industries in such a way that the ratio of their marginal productivities in the production of one commodity is equal to the ratio of the marginal productivities in the production of the other.[1]

Diagramatically, this can be shown in two ways.

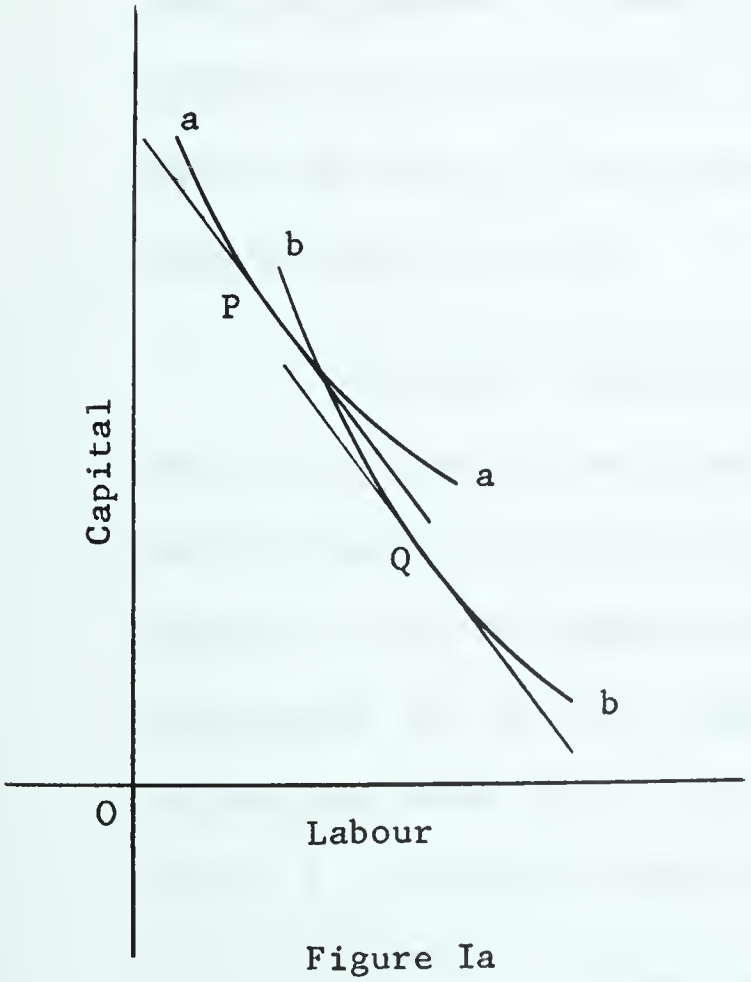

Figure Ia

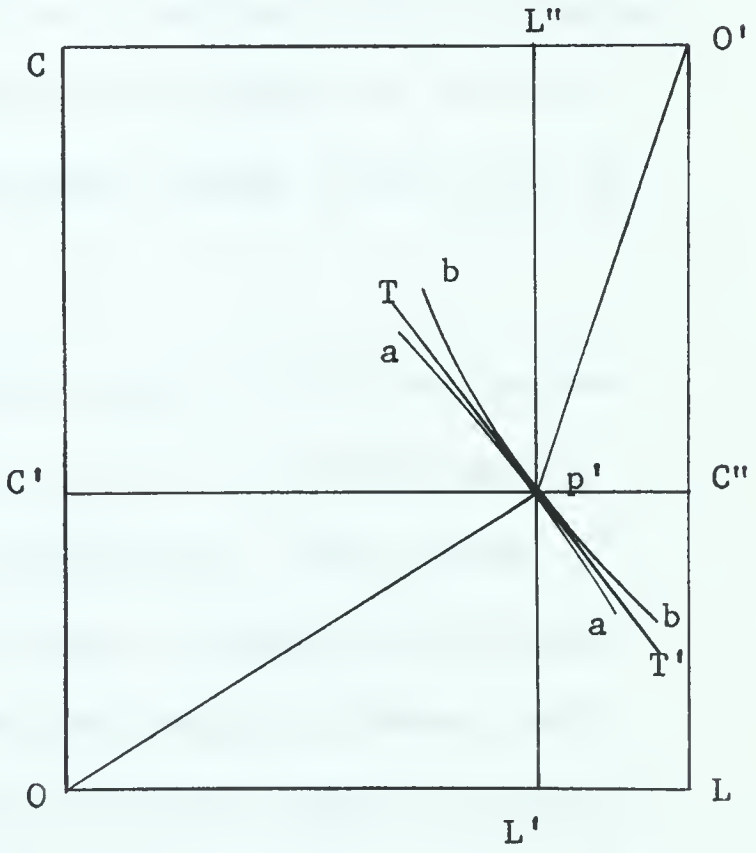

Figure Ib

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1 Ibid.

In figure Ia, we have isoquants aa and bb which show equal products of commodities A and B respectively. Labour input is shown on the horizontal axis and capital input is shown on the vertical axis. The isoquants have different positions relative to the axis because of different factor intensities of the two commodities. The commodity A is relatively capital intensive and the commodity B is relatively labour intensive. The slope of the isoquant at any point gives the ratio of the marginal products of labour and capital.[1] When we choose two lines of equal slope which are tangent to aa and bb at P and Q as shown in the diagram, the ratios of the marginal products of labour and capital in the production of commodities A and B are equal. OP and OQ, whose slopes indicate the ratios of the quantities of the two factors used in the production of A and B , respectively, therefore represent a possible equilibrium allocation of the two factors between the two industries.[2] The slopes of the tangents at P and Q give us the ratio of the prices of two factors (equal to the ratio of their marginal products).

We cannot determine the absolute amounts of the two factors that will be used in the production of A and B unless we specify the total amounts of the two factors of production. This is done in figure Ib. In the Edgeworth-Bowley box used in figure Ib, the horizontal axes OL or O'C represent the given supply of labour and the vertical axes OC or O'L represent the given supply of capital. Origin O is used for commodity B and O' is used for commodity A.

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[1] Ibid., p. 13

[2] Ibid., pp. 13, 14.

The point of tangency (p') between aa and bb represents a possible equilibrium point as the slopes of both the isoquants are the same at that point. As indicated earlier it follows that at this point the ratios of the marginal products of the two factors are equated in the production of the two commodities A and B. The amounts of labour and capital employed in the production of commodities A and B is shown by OL', OC', and O'L", O'C", respectively. It will be obvious that there is a continuous locus from O to O' of points of tangency (not shown here) between A-isoquants and B-isoquants. At any such point p', all the land and all the labour are distributed between the industries in such a way that the ratio of their marginal products is the same in each industry. Also, at any such point, (p' here), the factor proportions in commodity B and commodity A are represented by the slopes of OP' and O'P' respectively. The relative price of land and labour is represented by the slope of the tangent TT' in figure Ib.[1] Thus all the points of tangency between the isoquants aa and bb (the maximum efficiency locus) represent possible equilibrium points under perfect competition.

"The assumption of constant returns to scale is of great importance and needs elaboration."[2] It means that if both factors are increased or decreased in the same proportion from given amounts, the corresponding increase or decrease in the amount of product will be in

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[1] I am indebted to C. P. Kindleberger, International Economics (Homewood, Illinois: Richard D. Irwin, Inc., 1953), p. 599, for some of the ideas mentioned here.

[2] S. Mookerji, op. cit., p. 14.

equal proportion.[1] This assumption therefore excludes the possibility of long-run U-shaped cost curves.[2] The assumption of constant returns to scale defines the form of the production function.[3] "The function, in other words, must be linear and homogeneous."[4]

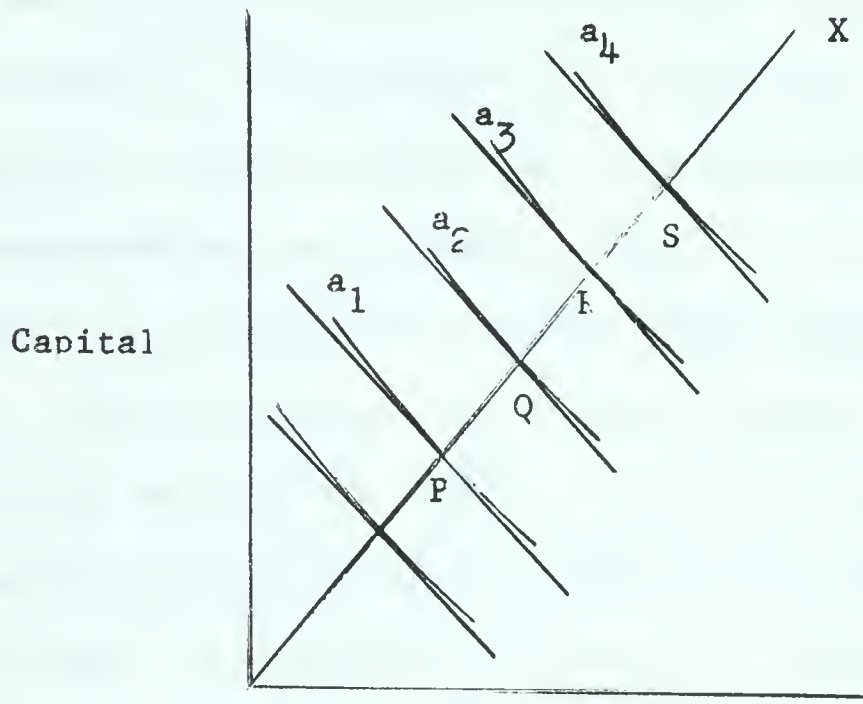

Figure 2.

In figure 2, the equal-product contours a_1, a_2, a_3, a_4, ... are drawn where output of a commodity A is the function of two factors, labour and capital.[5] The function is assumed to be linear and

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[1] Ibid.

[2] Ibid.

[3] Ibid., p. 15.

[4] Ibid.

[5] Ibid.

homogeneous.[1] The line OX is any ray through the origin cutting a_1, a_2, a_3, a_4, ... at P, Q, R, S ... respectively. For the function to be linear and homogeneous, each isoquant must have the same slope on any ray. The slope of a_1 at P equals the slope of a_2 at Q and so on. "Any contour is thus a radial 'projection' of any other and the whole system of contours can be derived if only one contour is given."[2] The distances OP, OQ, OR, OS from the origin on any given ray must be proportional to the respective amounts of output represented by the isoquants. Thus if OQ is twice the distance OP , isoquant a_2 represents twice the output represented by the isoquant a_1 . Since tangents to the various isoquants at points where they are cut by any ray OX must all be the parallel, the ratio of marginal productivities of the two factors must be the same, along any single ray (also the price ratio).[3] As scale effects are excluded by the assumption of constant returns, the marginal productivities of the factors depend only upon the ratio of their combination. As this ratio is the same along any ray through the origin like OX , the absolute marginal productivities of the factors must be the same at all points along OX.

The Heckscher-Ohlin theorem is that under the assumptions elaborated earlier a country will export goods which use relatively large amounts of its relatively abundant factor. The concept of relative

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1 Ibid.

2 Ibid.

3 Ibid., p. 16.

factor abundance may be defined in two ways.[1] It may be related either to factor prices or to factor proportions in physical terms. If we choose the former definition, then a country where capital is relatively cheap and labour relatively dear will be termed capital-abundant, whether or not the ratio of the total amounts of capital to labour in this country is higher than that in the other country.[2] Similarly, if we adopt the alternative definition, a country is relatively capital-abundant if the ratio of the amounts of capital to labour in this country is higher, whether or not the ratio of the prices of capital to labour is lower than that in the other country.[3]

If we start from the first concept, the Heckscher-Ohlin theorem follows immediately from the assumptions made above, and without any further assumptions as to the demand conditions or factor endowments. To prove this, let us assume country I to have relatively cheap capital and country II to have relatively cheap labour. Let PL_I and PL_{II} denote the prices of labour in country I and II respectively and PC_I and PC_{II} denote the prices of capital in them. Then our assumption about factor prices in the two countries is

$$\frac{PL_I}{PC_I} > \frac{PL_{II}}{PC_{II}} .$$ [4]

Let us further assume commodity A to be relatively labour intensive and commodity B to be relatively capital intensive. Now, we have to prove

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[1] Ibid., p. 11.

[2] Ibid., p. 12.

[3] Ibid.

[4] Ibid., p. 27

that the capital abundant country I will export the capital intensive commodity B and import the labour intensive commodity A from the labour abundant country II. Since, by assumption, the two countries have the same production function for each commodity, commodity A is labour intensive and commodity B is capital intensive in both countries.

In figure 3, we have two isoquants for the two commodities; aa for A and bb for B. The horizontal axis represents input of labour and the vertical axis that of capital. Let the slope of the line PQ represent the ratio of factor prices in country I. The line PQ touches A isoquant at R, and B isoquant at S.

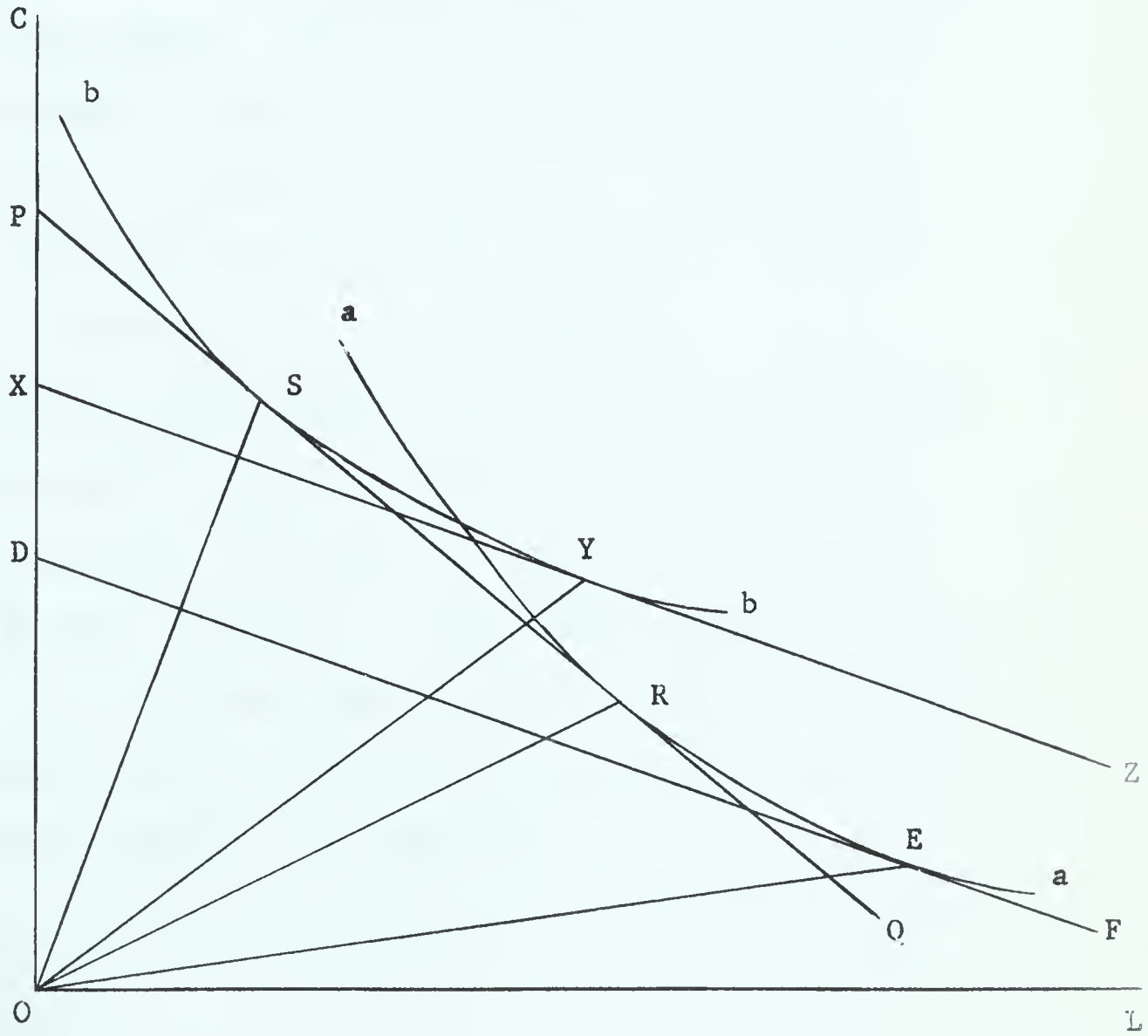

Figure 3.

Now since labour is relatively cheap in country II, the slope of the price line representing the ratio of factor prices there must be less than PQ.[1] Let the slope of DF represent the factor price ratio in country II. DF is tangent to the aa isoquant at E. Now we can draw a line XZ parallel to DF touching bb isoquant at Y. In country I the equilibrium factor proportions are OR for commodity A and OS for commodity B. In country II these are OE for A and OY for B.

The cost of producing the given amount of A in country I is the cost of using the factors in the quantities indicated by OR and at relative prices PQ.[2] If we take into account this cost in terms of only one factor, say capital, comparisons between the two countries and commodities are easier to make. The intercept of PQ with the vertical axis, at point P , shows OP , as the cost of producing the given quantity of either commodity in country I. Similarly, the cost expressed in terms of capital only of producing commodity A in country II is OD and that of commodity B in the same country is OX. As $\frac{OX}{OD} > \frac{OP}{OP}$, the relative cost of producing B in country II is higher, and the relative cost of producing A in country I is higher. Conversely we can say that commodity A is relatively cheap in country II and commodity B is relatively cheap in country I. Of course, this conclusion involves the equality of costs with prices, which needs no proof here as we have assumed perfect competition.

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[1] Ibid., p. 28.

[2] Ibid., p. 29.

Thus, the capital abundant country I has a comparative advantage in the production of the capital intensive commodity B and with the opening up of trade will export it to country II and import labour intensive commodity A from her. Thus with the definition of relative factor abundance in terms of factor prices, we reach the Heckscher-Ohlin trade result, although neither demand conditions nor knowledge of factor proportions are explicitly given.

Let us now consider the other definition of relative factor abundance, i.e., that in terms of the physical supplies of labour and capital. Let C_I, C_{II} denote the total supplies of capital in country I and II and L_I and L_{II} denote those of labour. Let us assume country I to be relatively capital abundant and country II to be relatively labour abundant. Then by this definition[1]

$$\frac{C_I}{L_I} > \frac{C_{II}}{L_{II}} .$$

This situation can be graphically represented by using two boxes of different sizes as in figure 4A and 4B. The horizontal axes AD and CB in figure 4A and A'D' and C'B' in figure 4B represent the given supply of labour and the vertical axes AC and DB in figure 4A and A'C' and D'B' in figure 4B represent that of capital. Let us assume commodity A to be relatively labour-intensive and B relatively capital intensive. The origins for A isoquants are A and A' in countries I and II respectively and those for B isoquants are B and B'. Since commodity A is relatively labour intensive the contract lines AXB and A'X'B' lie below the diagonals AB and A'B'. The isoquants are omitted from the diagrams for convenience.

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[1] Ibid., p. 30

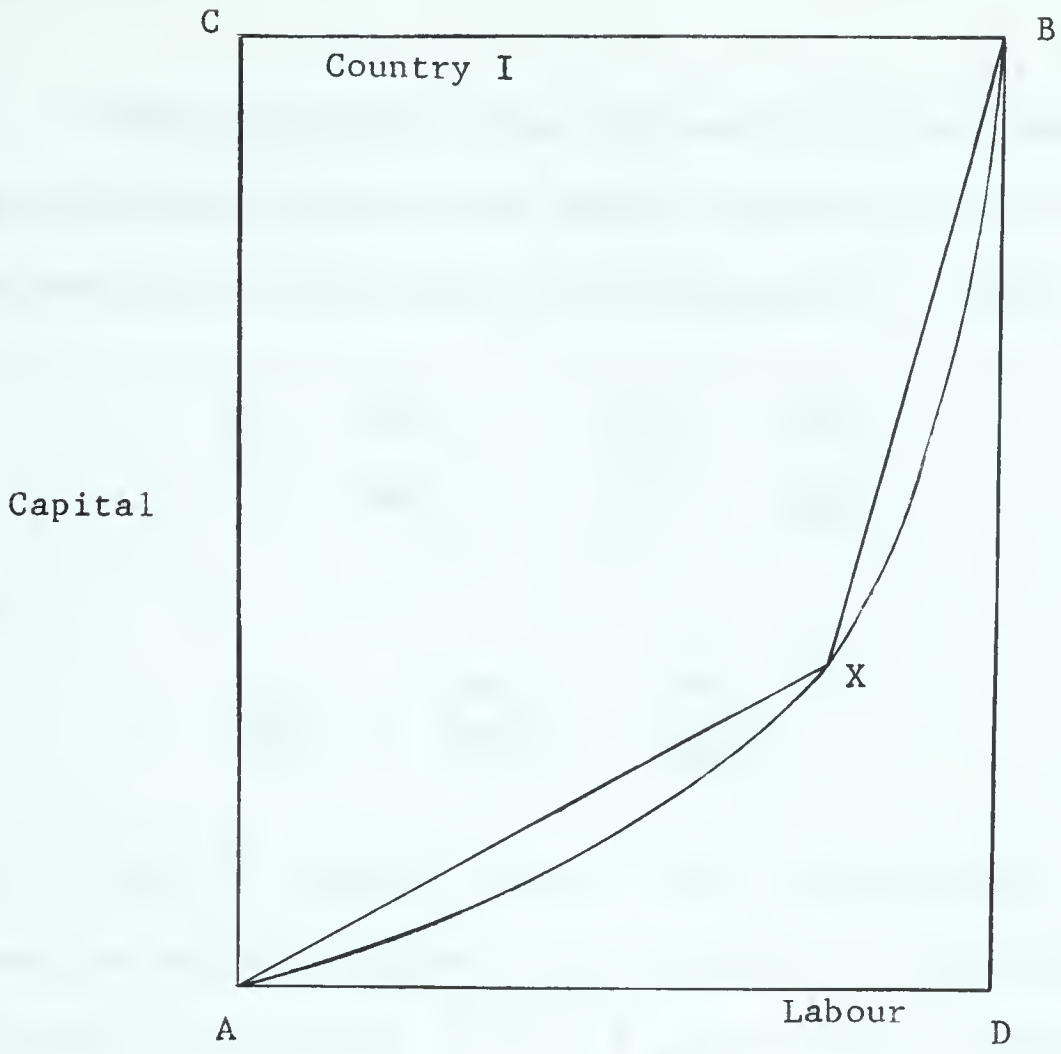

Figure 4A

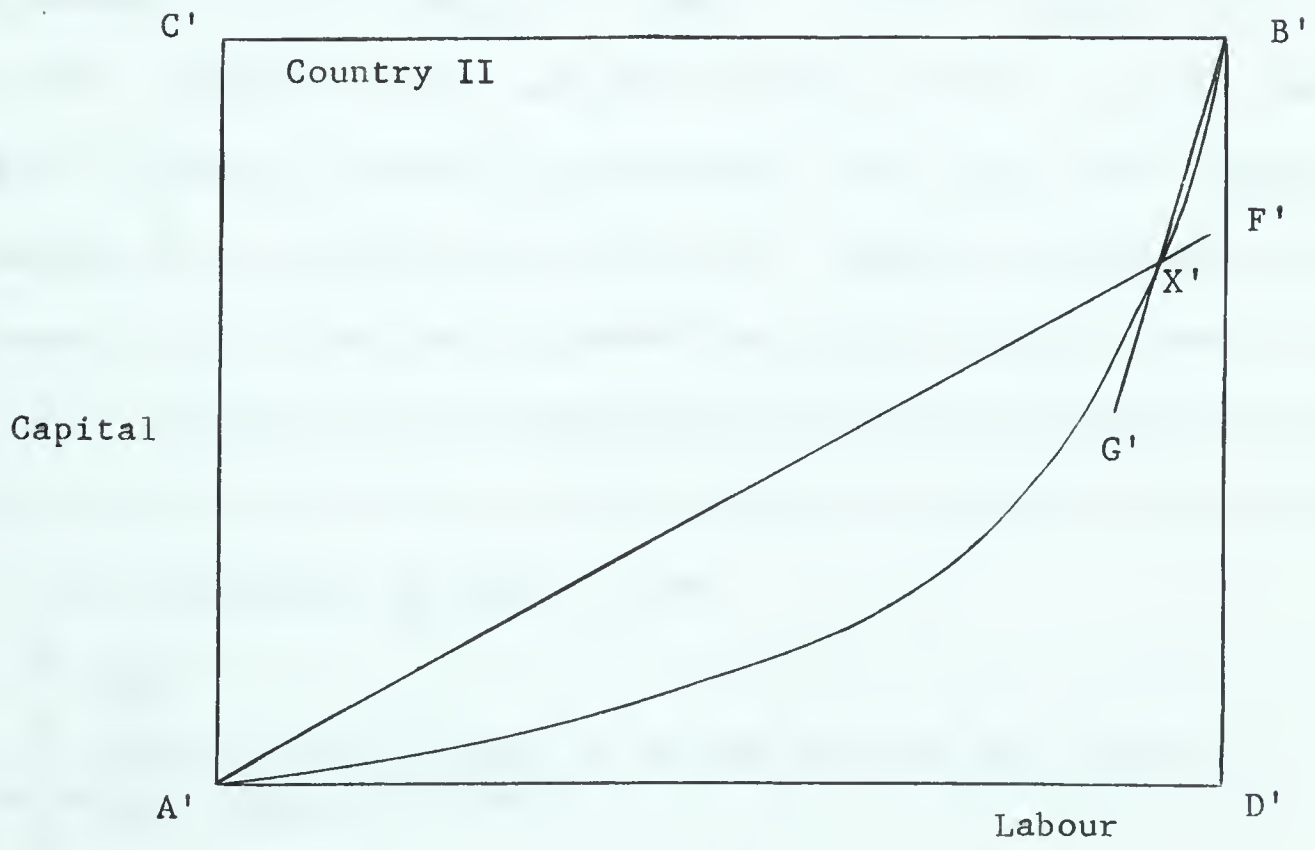

Figure 4B

"Since the points along the contract line represent equilibrium points under conditions of perfect competition, the payment to the factors must be the same in both industries."[1] That is,

$$PA \cdot MPL_A = PB \cdot MPL_B$$

$$PA \cdot MPC_A = PB \cdot MPC_B$$

whence

$$\frac{PA}{PB} = \frac{MPL_B}{MPL_A} = \frac{MPC_B}{MPC_A}$$ [2]

where PA and PB are the prices of the two commodities and MPL and MPC are the marginal physical productivities of labour and capital respectively; subscripts A and B are attached to signify these productivities in industry A and B respectively.

Now, to prove[3] that each country produces relatively more of the good intensive in its abundant factor let us take some point X on the contract curve of country I. Draw in A'C'B'D' (country II) A'F' and B'G' parallel to AX and BX so that $\angle D'A'F' = \angle DAX$ and $\angle D'B'G' = \angle DBX$. Let the point at which A'F' and B'G' intersect be called X'. It will be shown that X' lies on the contract curve of country II. It can now be proved that pairs of points, such as X and X', referred to as "corresponding points" by Lancaster,[4] are also

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[1] K. Lancaster, op. cit., p. 24.

[2] Ibid.

[3] The proof that follows is on the lines of that given by K. Lancaster, ibid., pp. 25-27.

[4] Ibid., p. 26.

possible trade equilibrium points, since such a pair of points satisfies the internal equilibrium conditions in each country. As production functions are identical for both countries, the set of A isoquants spreading out from origin A is the same as that spreading out from A'. Since $\angle D'A'X' = \angle DAX$, those properties relevant to A-isoquants which hold along AX also hold along A'X'. Similarly those properties relevant for the B-isoquants which hold along BX also hold along B'X'.

As the marginal productivities of labour and capital are the same along the ray AX (as proved earlier) in the production of A, they are also the same along A'X'. The marginal productivities of labour and capital in the production of B are also the same along B'X' as along BX. Since X and X' lie, respectively, on both AX, BX and A'X', B'X', the marginal productivities of labour and capital, in the production of both A and B, are the same at X' as at X.[1] In particular, since X lies on the contract curve of country I, the ratio between the marginal productivities of labour and capital, in country I, is the same in the production of B as of A.[2] The same equality holds, therefore, in country II, so that X' lies on the contract curve in country II. Since the commodity price ratio in country I is given by the ratio of the marginal productivity of a factor in one industry to that in the other, and both these marginal productivities are the same at X' as at X, it follows that the commodity price ratio is the same at X' as at X.[3]

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[1] Ibid., pp. 26, 27.

[2] Ibid., p. 27.

[3] Ibid.

The proof of the different proportions in which the two commodities will be produced by the two countries requires some additional manipulation. Taking the two diagrams as in figure 4, apply A'C'B'D' to ACBD so that D' coincides with D, D'A' lies along DA and D'B' lies along DB.[1] The result is shown in figure 5. Since A'D' > AD (to start with the theorem is proved for absolute amounts of factors; however, it is later on proved for the ratios of factors in the two countries) and B'D' < BD, it is clear that when A'C'B'D' is applied to ACBD, A' will lie to the left of A, so that A'X' will lie above AX and B' will lie below B so that B'X' will lie below BX, giving the configuration shown in figure 5.[2]

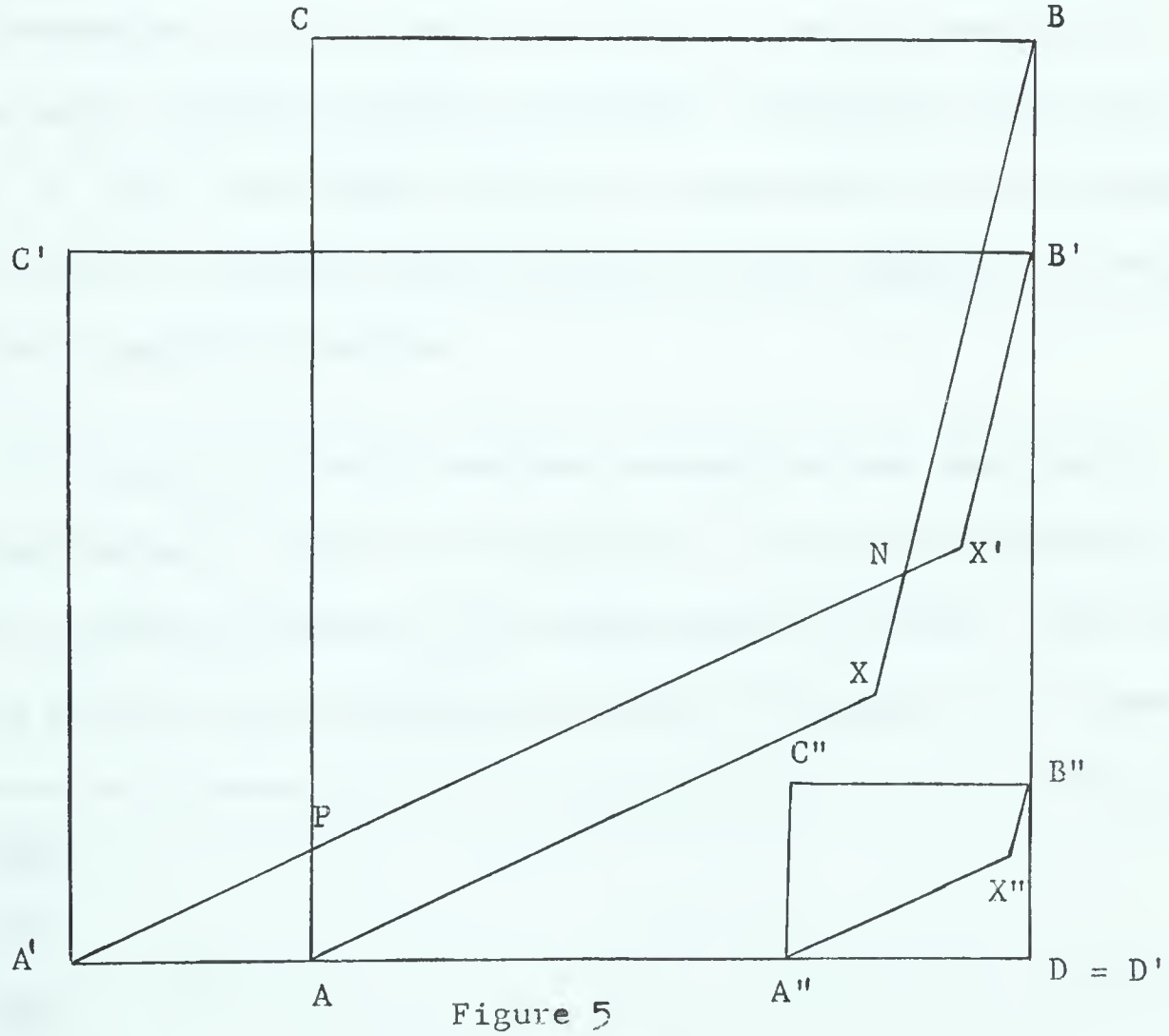

Figure 5

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1 Ibid.

2 Ibid.

Referring to the figure,

$$A'X' = A'P + PN + NX'.$$

Since PN is parallel to AX and NX does not have a negative slope, it follows that $PN \geq AX$. Hence,

$$A'X' \geq A'P + NX' + AX$$
$$> AX .$$ [1]

But, from the properties of the ray from the origin, (examined earlier), the production of A in country I is proportionnal to the length of AX and the production of A in country II is proportional to the length of $A'X'$.[2] Since $A'X'$ is greater than AX, the production of A is greater in country II than in country I. Similarly, it can be shown that the production of B is less in country II than in country I.[3]

Thus, the labour abundant country II produces relatively more of the commodity A which uses labour relatively intensively and the capital abundant country I produces relatively more of the commodity B which is relatively capital intensive.

So far, each country has been assumed to have absolutely more of one factor.[4] This is not assential. In the same diagram 5, a shrunken version of country II is represented by A"C"B"D. Since this country is similar in all respects to country II except in scale and

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[1] Ibid.

[2] Ibid.

[3] Ibid.

[4] Ibid., p. 28.

there are no scale effects in production, the theorem proved for the larger country holds for this country as well. As the ratio of A to B will remain the same irrespective of the scale, the shrunken version of country II will also produce relatively more of commodity A.

In the preceding analysis, it was assumed that the lines A'F' and B'G' in country II (figure 4B) intersect inside the box. It can, however, be shown that there are points on the contract curve of country I which have no corresponding points in country II and vice versa. Corresponding points are those, such as X and X', at which (referring to figures 4A and 4B) $\angle D'A'F' = \angle DAX$ and $\angle D'B'G' = \angle DBX$. It is also possible that there are no corresponding points between the two economies.

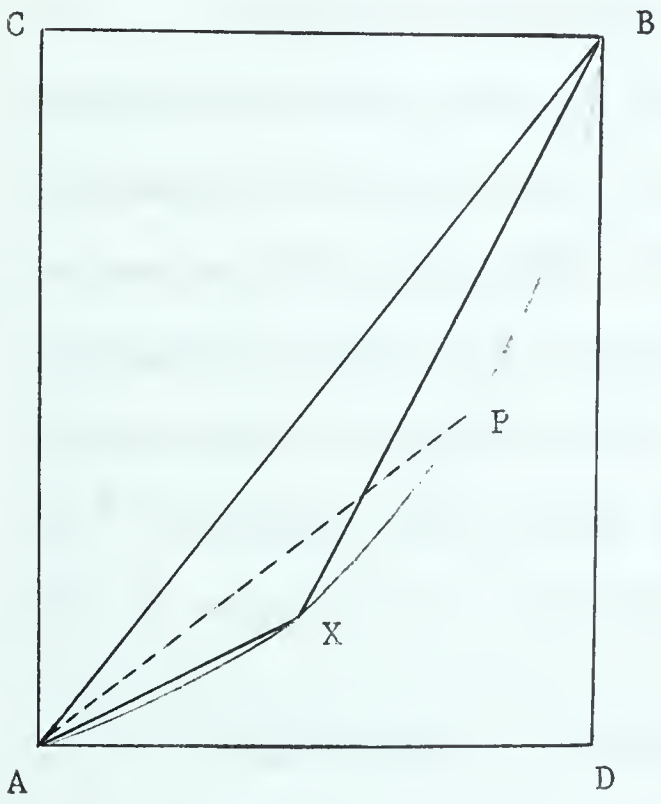

Figure 6A Country I

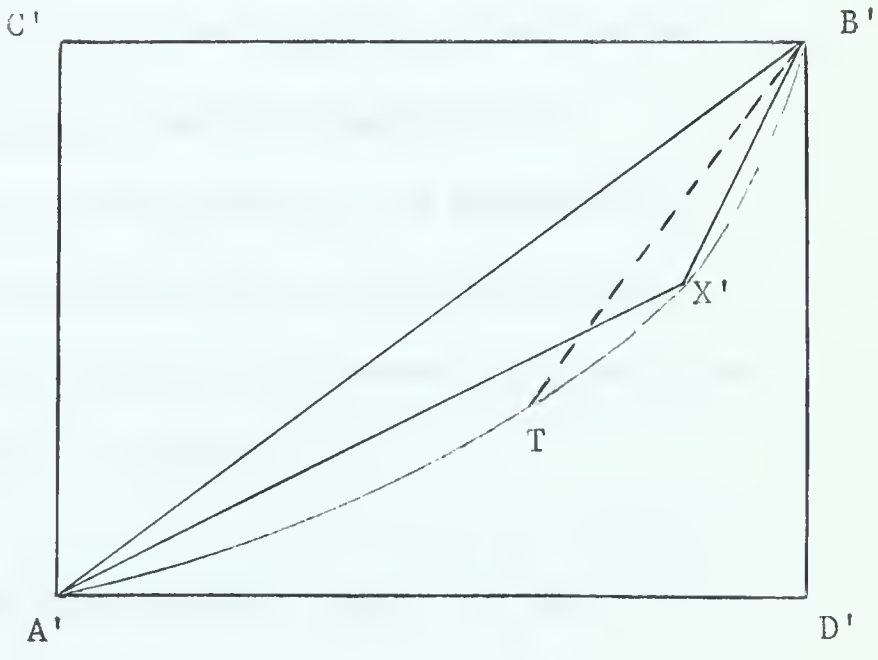

Figure 6B Country II

In diagrams[1] 6A and 6B, the point X on the contract curve (AXPB) of country I has a corresponding point, X', on country II's contract curve (A'TX'B'). If, however, we move from X in country I in a north easterly direction a point p is reached where $\angle DAP = \angle D'A'B'$ in country II. That is, the point corresponding to P in country I is point B' in country II. The points on the segment PB in country I will have no corresponding points on the country II's contract curve.[2] Similarly, if we move in a south-westerly direction from X' on country II's contract curve, we reach a point T, where $\angle D'B'T = \angle DBA$. Thus point A on the contract curve of country I corresponds to the point T on the country II's contract curve and the segment TA' on country II's contract curve has no corresponding points on the country I's contract curve.

Consider the commodity price ratios on the segments of the contract line which have no corresponding points in the other country.[3] In country I in figure 6A, point p is the corresponding point to B' in country II in figure 6B.[4] Now any point on the segment PB represents a ratio of the price of A to the price of B higher than that at point P, and so higher than at point B' or any other point in II.[5] Similarly points along TA' in country II represent a higher price for B relative to A than any points in country I.[6]

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1 These diagrams are taken from K. Lancaster, ibid., p. 29.

2 Ibid.

3 Ibid., p. 30.

4 Ibid.

5 Ibid.

6 Ibid.

In other words, if the price ratio in trade leads to a point in one country to which there is no corresponding point in the other country, the second country will always specialise in production, using the whole of its resources to produce the good most intensive in its most abundant factor.[1]

Till now, we have proved only that a difference in relative factor endowments by itself establishes a comparative advantage in production. We have not yet proved the Heckscher-Ohlin proposition, according to which each country should also export the commodity intensive in its relatively abundant factor. In the foregoing, we have analysed relative production of the two commodities in each country at a certain commodity price ratio after trade. What this price ratio would be depends on demand conditions in the two countries. However, in the case where factor endowments are such that there are no pairs of corresponding points on the contract curves of the two countries, each will specialise completely in the production of the commodity in which it has comparative advantage, and will export the commodity intensive in its abundant factor, whatever the demand conditions. Thus, the Heckscher-Ohlin result follows without the additional demand conditions.

The cases, however, where there exist pairs of corresponding points in the two countries and where the demand conditions are relevant for the determination of relative commodity prices, are easier to handle

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[1] Ibid.

with the help of transformation curves. In figure 7[1] two transformation curves between commodities A and B are drawn; PQ is the transformation curve for the capital-abundant country I and MN for the labour-abundant country II. These transformation curves can be directly derived from the contract curves for the relevant countries drawn earlier in this chapter. Commodity A is relatively labour intensive and commodity B relatively capital intensive; they are measured along horizontal and vertical axes respectively. If the slopes of curve PQ at points P

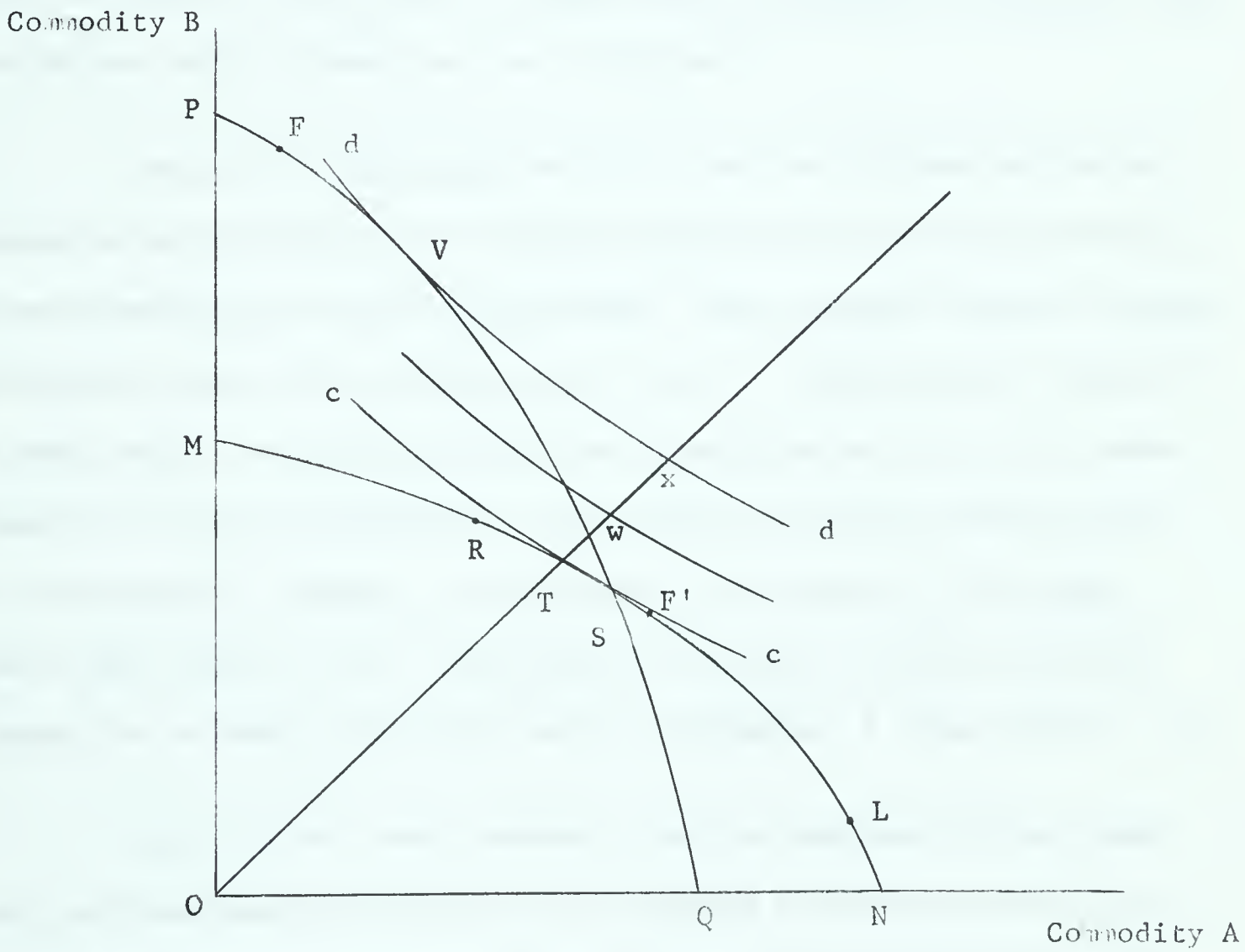

Figure 7

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[1] This diagram is taken from S. Mookerji, op. cit., p. 42.

and S are equal to those of curve MN at points R and N respectively, then any point F on the segment PS of the PQ curve must have a slope equal to that of some point F' on segment RN of the MN curve.[1] In equilibrium, the commodity price ratio, $\frac{PA}{PB}$, must be equal to the marginal rate of transformation as given by the slope of the curve.[2] Hence, if the commodity price ratio after trade is equal to the slope of a point, say F, on segment PS of the PQ curve, it must also be equal to the slope of the corresponding point F' on segment RN of the MN surve, so that all such pairs of points may be regarded as possible trade equilibrium points between the two countries.[3]

Comparative advantage resulting from the differential factor endowments can be seen by the different opportunity costs for producing the two commodities in the two countries. Draw a radius from the origin meeting the curves PQ and MN at W and T respectively. Being on the same radius the outputs of the two commodities will be in the same proportion in the two countries. The slopes of the two curves at the two intersections, however, are different, the slope of PQ being greater than that of MN. This means that country I which is capital abundant has a lower opportunity cost of producing B than country II.

This does not mean, however, that the Heckscher-Ohlin trade result will necessarily follow. If the demand conditions in the two countries prior to trade are such that country I is in equilibrium at

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[1] Ibid., p. 41.

[2] Ibid.

[3] Ibid.

point F and country II is in equilibrium at point L, then commodity A which is relatively labour intensive is relatively cheap in the capital abundant country I, so that the result goes against the Heckscher-Ohlin theorem. The capital abundant country I will export the relatively labour intensive commodity A.

If, however, the taste pattern in the two countries is the same and if the income elasticity of demand for each good is unity, the slope at the equilibrium point (prior to trade) of country I's transformation curve will be steeper than that of a similar point on country II's transformation curve and the Heckscher-Ohlin theorem will hold. This is demonstrated by the two equilibrium points V and T in country I and II, respectively, (in figure 7) at which the two community indifference curves dd and cc (belonging to the same family of indifference curves) are tangent with the two transformation curves PQ and MN respectively. The use of the community indifference curves is made purely as a heuristic device and the practical difficulties of deriving them are assumed away.[1]

Now, it is possible that the shape of the higher indifference curve dd is such that it is tangential to PQ at a point very close to P, so that the slope of PQ is less than that of MN at T. In this case the Heckscher-Ohlin trade result will not follow. This possibility is, however, excluded by the assumption of unit income elasticities of demand for both the goods. The income consumption curve under this assumption will be a straight line through the origin, or, alternatively, any radius drawn from the origin would cut the successive indifference

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[1] Ibid., p. 43.

curves at points which have the same slope.[1]

Earlier we have seen how differential factor endowments result in making the curve PQ steeper relatively to MN at the points of intersection between them and any radius drawn through the origin O to meet them. If the slope of PQ at W in figure 7 is greater than that of MN at T the tangency between PQ and an indifference curve must occur at a point to the left of W where the slope of the indifference curve must be greater than that at X . In other words, if income elasticities of demand are unitary, the tangent between PQ and an indifference curve must be steeper than that between MN and an indifference curve - and this assures the Heckscher-Ohlin result.[2]

. ."It should be noted that although the above assumption relating to demand is a sufficient condition for the Heckscher-Ohlin trade result, it is not a necessary condition."[3] Without identical demand in both countries and also without the unitary income elasticities of demand, it is possible that equilibrium in the two countries would occur at points where the labour intensive commodity A will be produced relatively cheaply and exported by the labour abundant country II, and the Heckscher-Ohlin trade result will follow. However, it is also possible in these cases to have the opposite result, which is not possible in case of identical demand and unitary income elasticities of demand.

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[1] Ibid., p. 44.

[2] Ibid.

[3] Ibid.

At this stage it is necessary to relax the assumption that a commodity is intensive in one factor at all sets of factor prices. The isoquants for the two commodities A and B now intersect twice. In figure 8[1] we have isoquants a_1a_1 (for commodity A) and $b_1'b_1'$ (for commodity B) intersecting twice (at P and P') and isoquants a_1a_1 and b_1b_1 (for commodity B) tangential to each other at T. On the isoquants a_1a_1 and b_1b_1, for two pairs of points with parallel tangents

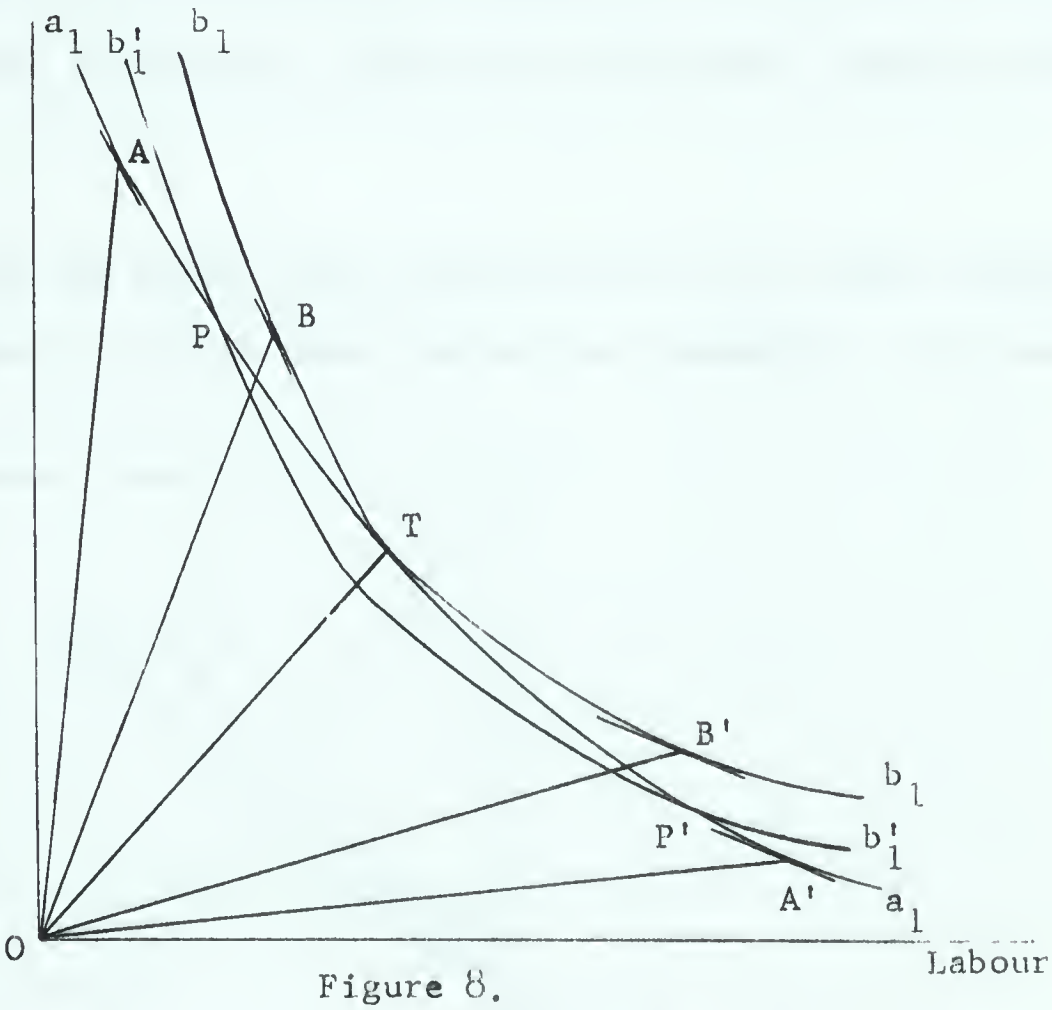

Figure 8.

such as A, B and A' , B' at opposite ends of the isoquants, OA has a steeper slope than OB , but OA' has a more shallow slope than OB'.[2] At a low relative price of capital (shown by the tangents in the region to

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[1] This diagram is taken from K. Lancaster, op. cit., p. 33.

[2] Ibid.

the left of T), commodity A is relatively capital intensive but at a high relative price of capital (shown by the tangents in the region to the right of T) commodity A is relatively labour intensive; the relative factor intensities of A and B are reversed.[1]

In this case we can no longer say that one commodity is intensive in one factor at all sets of factor prices. But can we say that a commodity will be relatively intensive in one factor at all equilibrium factor price ratios, when the total factor supplies are specified?[2]

Suppose the given factor supplies are in the ratio indicated by OR in figure 9. It was shown before that commodity A is relatively

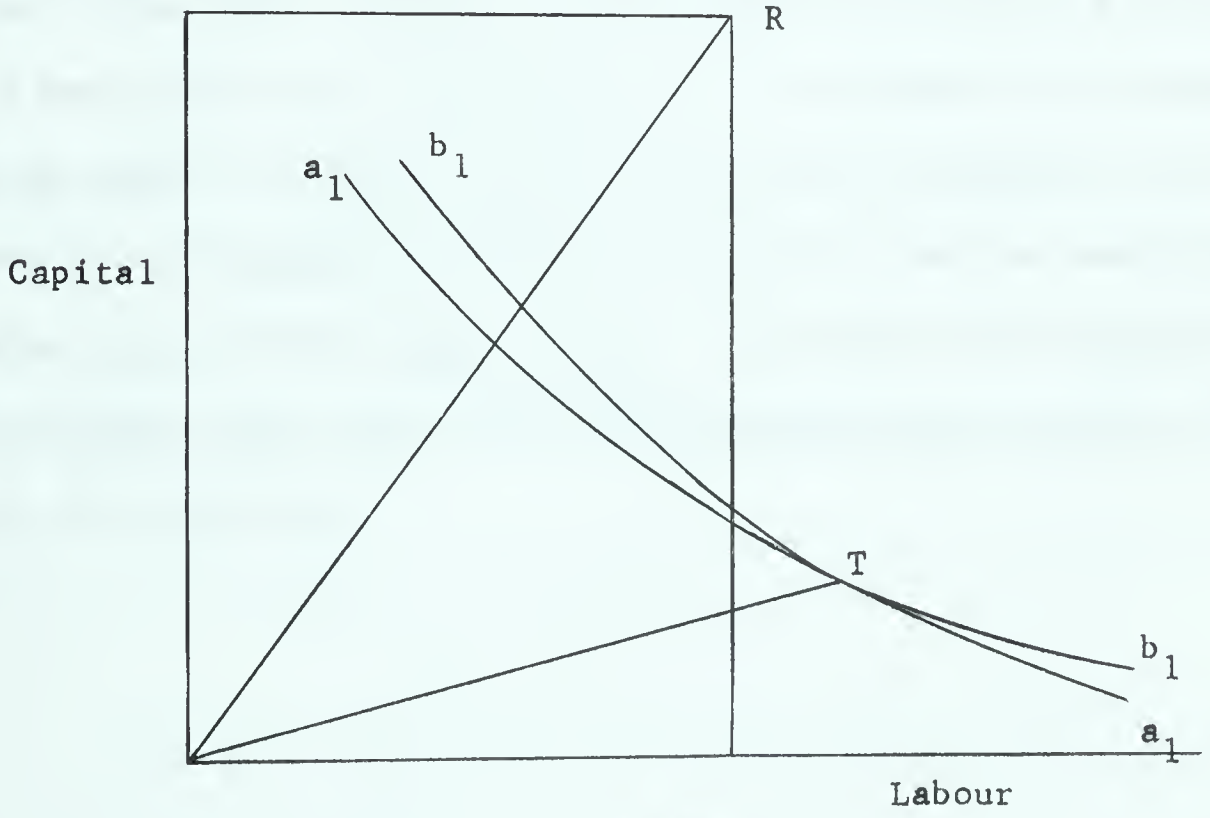

Figure 9.

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1 Ibid.

2 S. Mookerji, op. cit., p. 23.

capital intensive if the relative factor price ratio is given by the slopes of the tangents in the region to the left of T. As can be seen from the figure 9 only the regions to the left of T are covered by the given factor supplies so that the previous analysis of factor intensities applies here also. Thus if the factor supplies in the two countries are such that a commodity which is intensive in one factor in one country is also intensive in the same factor in the other country (i.e. the factor supplies lie to the left or to the right of T in both the countries), the previous analysis will hold and the Heckscher-Ohlin trade result will follow.

But, if the factor supplies in the two countries are such that a commodity is intensive in one factor in one country and in the other factor in the other country (i.e. the factor supplies lie to the left of T in one country and to the right of T in another) the Heckscher-Ohlin theorem cannot be proved. In fact, given the assumption that the same commodity is intensive in different factors in the two countries, the theorem can no longer apply to them. It is one of the assumptions of the Heckscher-Ohlin theory that the production functions are the same in the two countries.

CHAPTER IV

THE FACTOR PRICE EQUALISATION COROLLARY OF THE HECKSCHER-OHLIN THEOREM

We will be dealing with the factor price equalisation corollary of the Heckscher-Ohlin theorem in this chapter. This corollary assumes a special significance in the Heckscher-Ohlin model because earlier international trade theory consisted primarily of propositions about the relative prices of goods. This model provided, for the first time, an analysis capable of integrating the factor markets into international trade theory in a satisfactory way.[1]

It is essential to trace diagrammatically how trade between the two countries affects the factor prices. The relative prices of the commodities can be shown to advantage with the help of production possibility curves. It is profitable for the two countries to trade with each other if the pre-trade relative prices of the two commodities are different in each country. With the opening of trade, the commodity with a lower relative price is exported and the one with a higher relative price is imported. The relative price of the commodity exported rises in the exporting country and that of the commodity imported rises in the other country. This process continues until the relative difference in the prices is wiped out completely.

We have already seen in the earlier chapter how the contract curves for the two countries are constructed from the isoquants of the two commodities A and B when the physical endowments of the factors

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[1] K. Lancaster, op. cit., p. 19

(Labour and Capital here) are given. From these contract curves we can construct the production possibility curves for the two countries, by marking off all the points on the contract curves in terms of the two commodities (denoted by the isoquants). The relative prices of the two commodities (the price of commodity A in terms of commodity B and vice versa) in the two countries are shown by the slopes of the tangents at any points on the two production possibility curves.

The two production possibility curves shown in figures 11A and 11B for the two countries I and II, respectively, are constructed from the two contract curves in figure 10. We continue to assume that commodity A is relatively labour intensive and B relatively capital

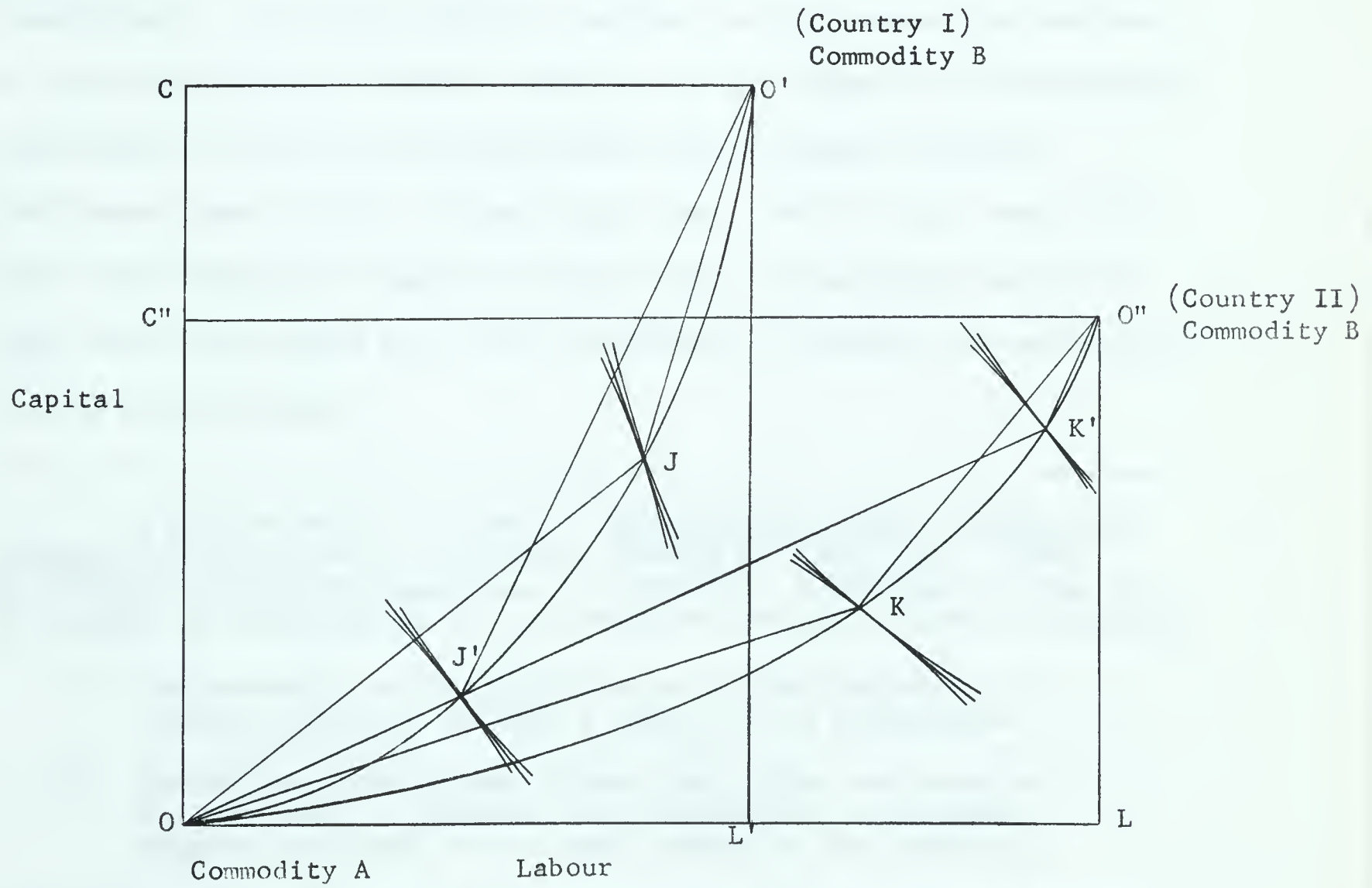

Figure 10

intensive and that country I is relatively capital abundant and country II relatively labour abundant. These two countries in figure 10 are shown as having OL', OC and OL, OC" of Labour and Capital respectively. The origin for commodity A is from O for both the countries and that for commodity B is from O' for country I and O" for country II.

The production possibility curve, BA , for country I is shown in figure 11A and that for country II, B'A' , is shown in figure 11B. Units of commodity A are shown on the X-axis and of commodity B on the Y-axis. The units that will be produced are shown by the points of tangency of the community indifference curves[1] with the production possibility curves, shown by the points m and n in country I and II respectively. As we did implicitly earlier, we will assume the same set of indifference curves for both countries in the beginning (to demonstrate the process of factor price equalisation) and introduce different indifference maps for the two countries later. We will also assume that there exist inside the Edgeworth-Bowley boxes corresponding points, at which the factor prices will be in equilibrium. However, this assumption will be relaxed later.

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[1] As pointed out by J. Vanek in International Trade: Theory and Economic Policy (Homewood, Illinois: Richard D. Irwin, Inc., 1962), pp. 221-22, in order to permit use of community indifference curves one of a number of different sets of alternative assumptions must be selected:

1. The community, either by voting or through decision of a central authority, defines a single set of preferences.

2. The ordinal preferences of every individual are identical and the level of income of all individuals is the same, whatever the level of the total income of the community.

Only the above two of several alternative sets of assumptions are given here. They are enough to give one an idea of the difficulties involved in constructing community indifference curves. However, these difficulties are assumed away for the purpose of the present analysis.

The tangents at m and n , MM and NN , for the countries I and II respectively (which show the relative prices of the two commodities in these countries) have different slopes, indicating different relative prices of the two commodities in the two countries. Since the pre-trade relative prices are different, the two countries will trade as it is profitable for them to do so (i.e., they can reach a higher indifference curve through trade). With the opening of trade, the amounts of commodities A and B exported and imported in the two countries and the price at which they will be exchanged will be determined by parallel lines tangent to the respective production possibilities curves, tangent to a higher indifference curve, and of equal length between the points of tangency.[1]

The requirements that the lines must be parallel, or of the same slope, fulfills the condition that the prices in the two countries must be the same after trade.[2] Only one price can prevail for a commodity in both the countries under perfect competition and costless trade. The requirement that they be of equal length satisfies the necessary condition that exports of one country shall be equal to imports of the other.[3]

This is shown diagrammatically by the lines M'M' and N'N' in countries I and II, respectively, which are: (1) tangent to the production possibility curves at m' and n' ; (2) tangent to higher

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[1] C. P. Kindleberger, International Economics (Homewood, Illinois: Richard D. Irwin, Inc., 1953), p. 112.

[2] Ibid.

[3] Ibid.

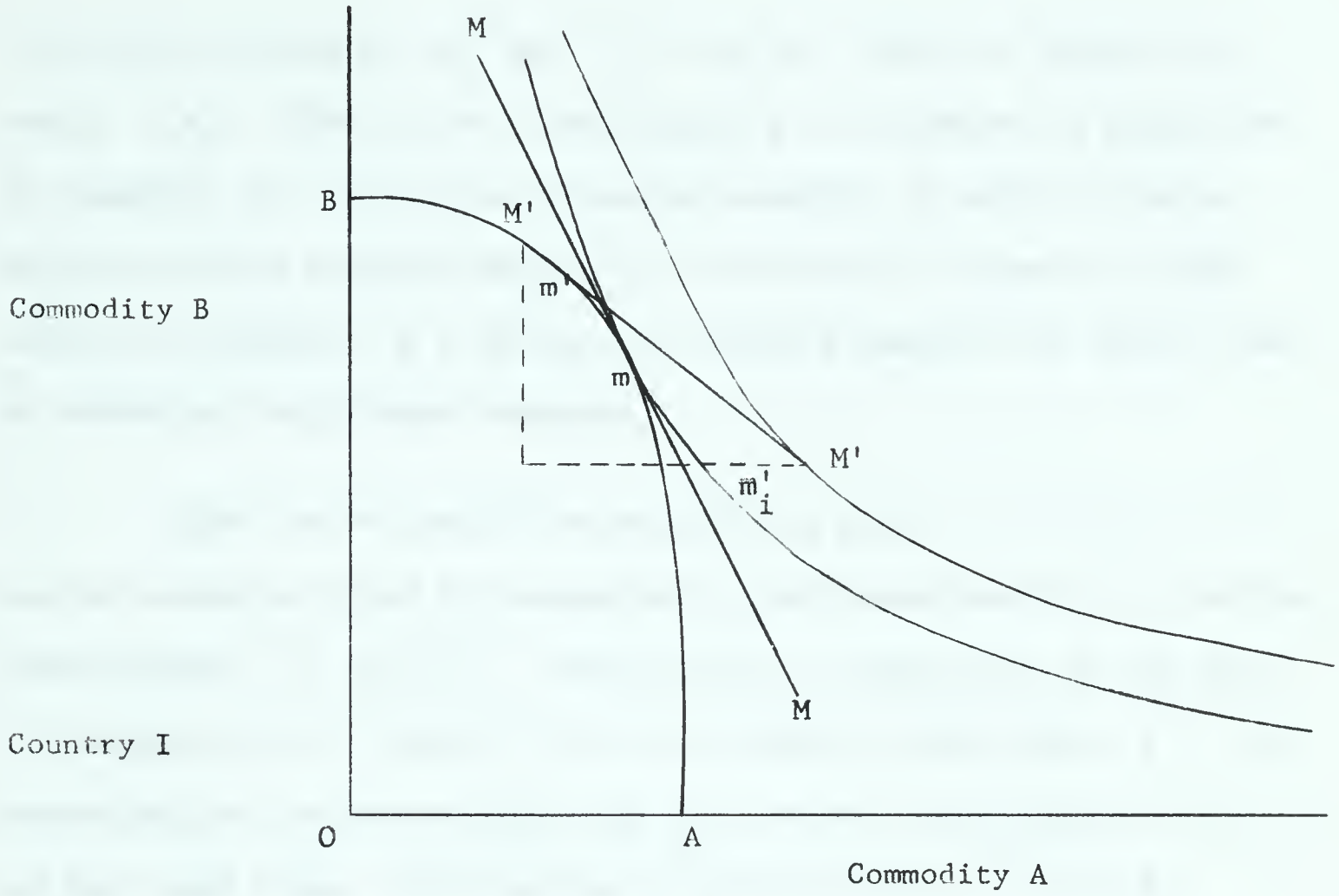

Figure 11A

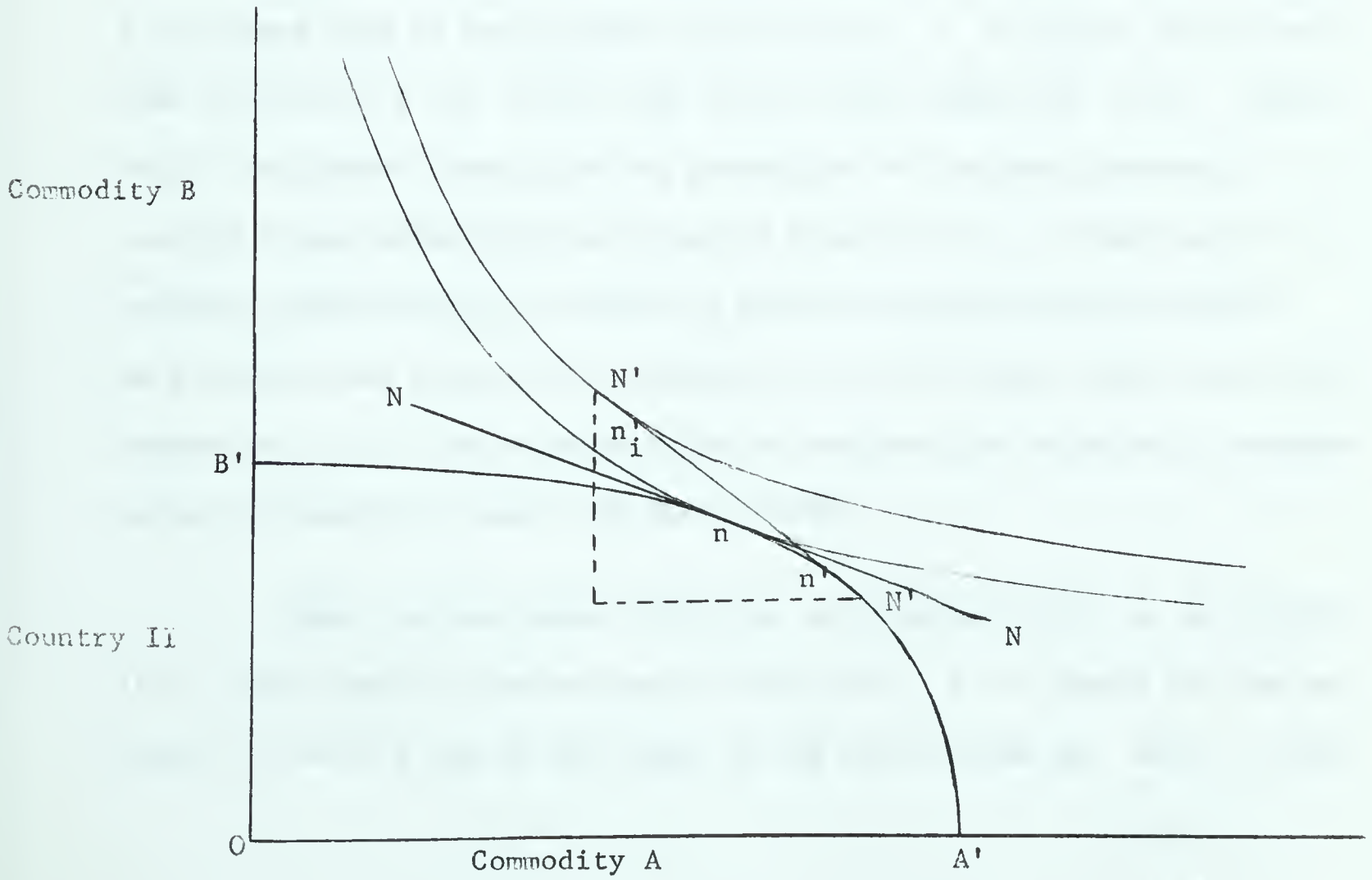

Figure 11B

indifference curves at m'_i and n'_i, and (3) equal in length ($m'm'_i$ equals $n'n'_i$). Thus, after trade country I has expanded its production of commodity B, the capital intensive commodity in which it has an advantage (being capitabl abundant); and country II expands its production of commodity A, the labour intensive commodity in which it has an advantage (being labour abundant).

When the two production equilibrium points m' and n' in the two countries I and II, respectively, are traced back to the contract curves (points J' and K', respectively, in figure 10), we see that the tangents at J' and K' lie on the same ray from origin O. As proved earlier (in Chapter III, page 31), because the tangents on any ray have same slope, factor prices are equialized at J' and K'.

When the pre-trade production equilibrium point m in country I is traced back to the contract curve (point J in figure 10) we see that it lies on a ray to the left of the after trade ray OJ'K'. This means that before trade, for the production of the same commodity, country I uses relatively more capital (than at J'). This lowers its marginal productivity, the value of which is equated with its price. As a result, the slope of the tangent at J is steeper than that of the tangent at J'. The relative price of capital, the relatively abundant factor in country I, has risen after trade.

When the pre-trade production equilibrium point n in country II is traced back to the contract curve (point K in figure 10), we see that it lies on a ray to the right of the after-trade ray OJ'K'. This

means that before trade, for the production of the same commodity, country II uses relatively more labour (than at K'). This lowers the marginal productivity of labour, the value of which is equated with its price. As a result the slope of the tangent at K is less steep than that of the tangent at K' . The relative price of labour, the relatively abundant factor in country II has risen after trade.

We have seen now that

1. the after trade factor price ratio is the same in the two countries;

2. the before trade relative price of capital is lower than the after trade price in country I;

3. the before trade relative price of labour is lower than the after trade price in country II.

From these conclusions it follows that, before trade, capital is relatively cheaper in country I than in country II; and that, before trade, labour is relatively cheaper in country II than in country I.

With the opening up of trade, the increased demand for capital intensive commodity B (of country I) from country II makes capital relatively scarcer after trade than it was before trade in country I, and this leads to a rise in its price. Similarly, labour in the labour abundant country II becomes scarcer after trade due to increased demand for the labour intensive commodity A from country I, and this leads to a rise in wages. This process continues till complete factor price equalization takes place at J' and K' in the two countries I and II respectively.

Now we can relax the assumption of identical tastes in the two countries and see its effects on factor prices in the two countries. Pre-trade factor price ratios are determined by conditions of both demand and supply, and differences in the relative physical endowments impart a bias on the supply side which may be overweighed by dissimilarities in demand as shown in figures 12A and 12B. The relative price of the labour intensive commodity A is higher in country II in spite of the fact that country II has a larger relative physical endowment of labour. Similarly the relative price of the capital intensive commodity B is higher in country I in spite of its relatively larger endowment of capital. These relative price ratios are shown by the tangents CC and DD in countries I and II respectively in figure 12A.

Thus with trade the capital rich country I concentrates on the production of the labour intensive commodity A in order to export ei of it in exchange for imports ef of the capital intensive commodity B. Similarly, the labour-rich country II concentrates on the production of the capital intensive commodity B in order to export e'f' of it in exchange for imports e'i' of the labour intensive commodity B. Note that in free-trade equilibrium, the triangles efi and e'f'i' are identical.

Tracing back these points to the contract curves of countries I and II in figure 12B, we find that the pre-trade factor price ratios are given by the tangents at the points M and N respectively. The after-trade factor-price ratios are given by M' and N' in the countries I and II respectively. The factor prices as in the earlier case are completely equalized after trade as the after-trade points M' and N' lie on the same ray.

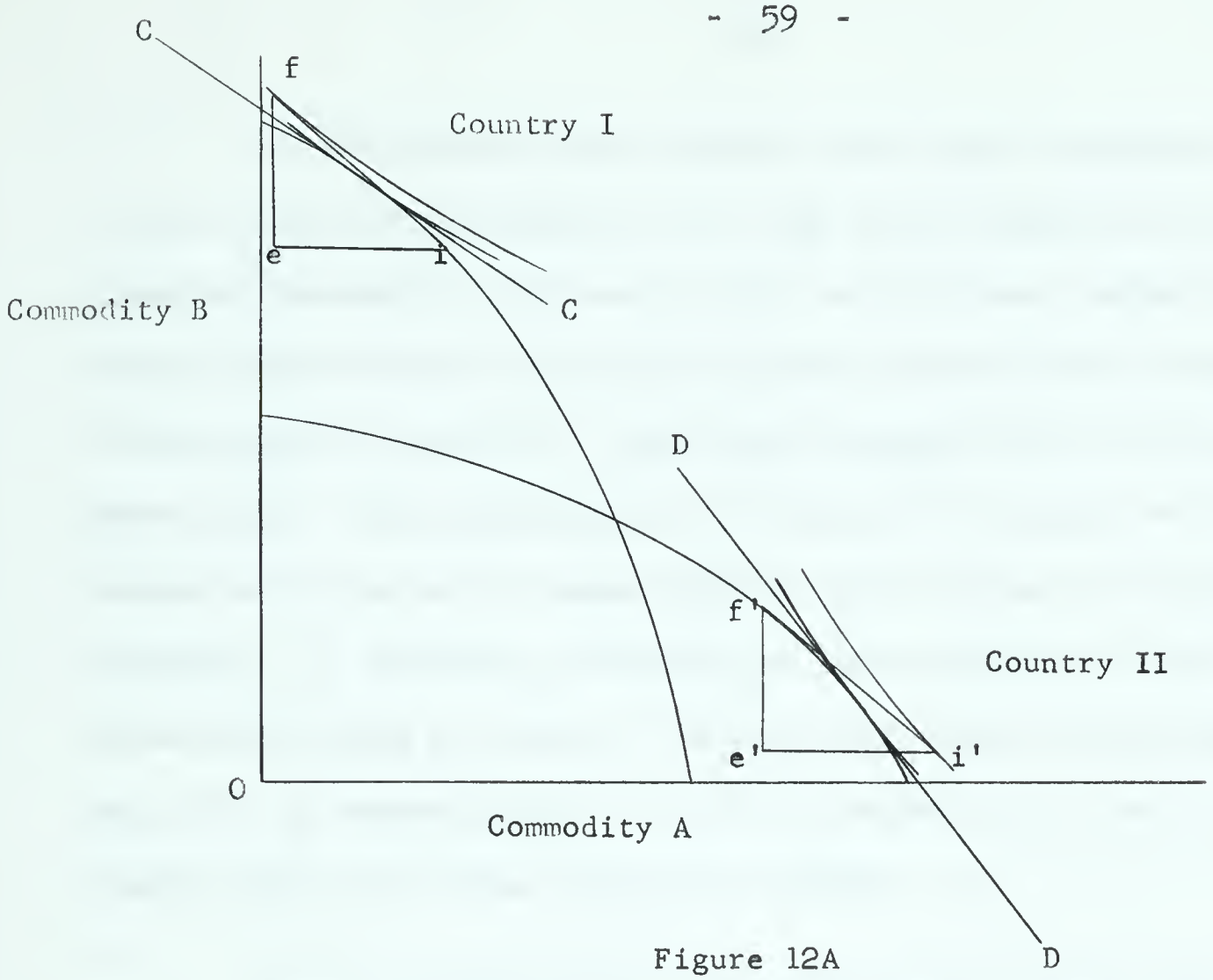

Figure 12A

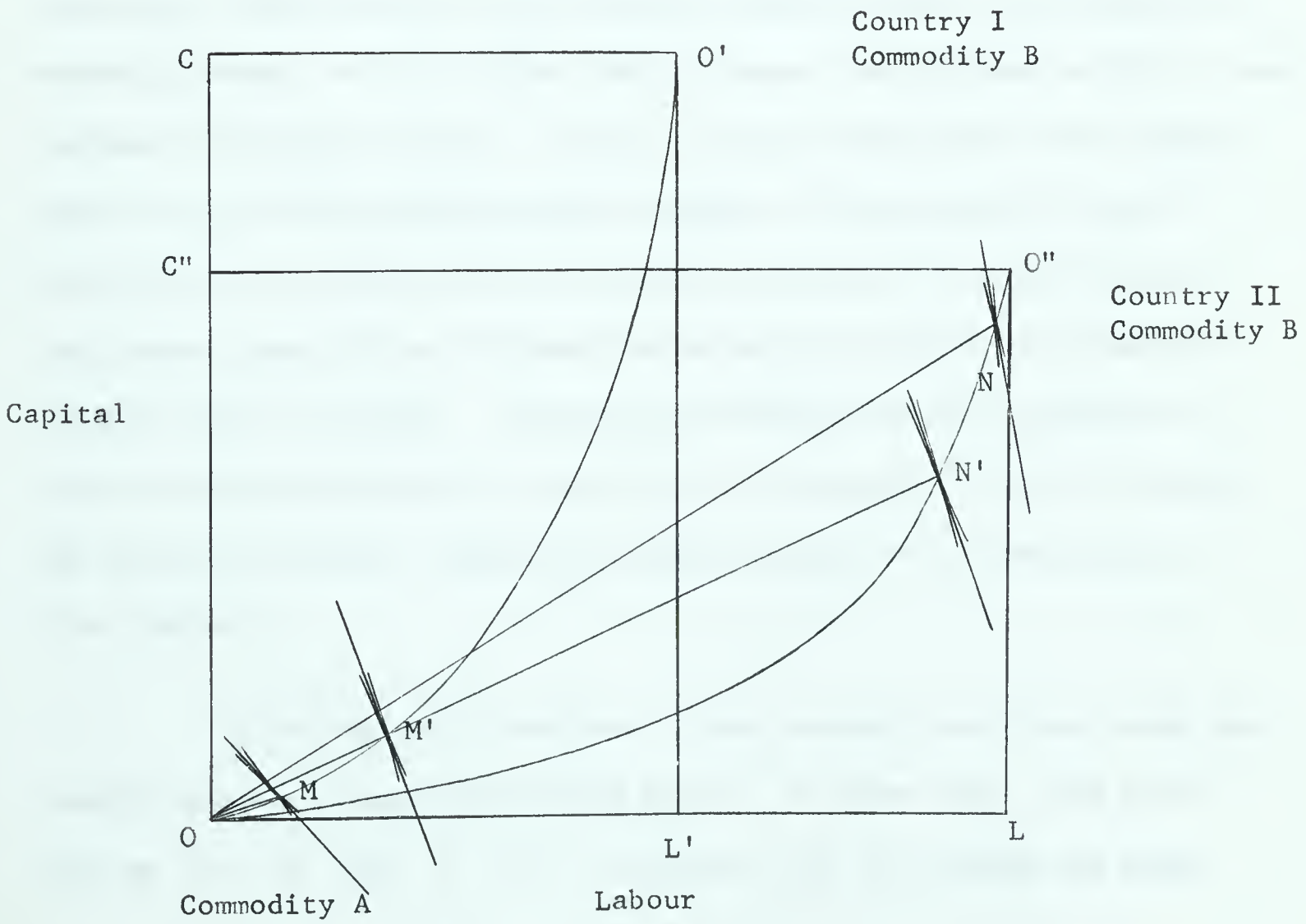

Figure 12B

In the earlier case, capital in the capital abundant country I rose in price after trade due to a rise in the demand for the capital intensive commodity B by country II. In this case, capital in country I has fallen in price after trade as shown by the steeper slope of the tangent at point M' after trade compared with the slope at M before trade. The relative price of capital in country I has fallen because of a rise in the demand for the labour intensive commodity A by country II. Similarly, wages in the labour abundant country II have fallen after trade as shown by the less steep slope of the tangent at point N' in comparison to N. This is caused by the rise in demand by country I for the capital intensive commodity B.

Thus, although factor price equalisation takes place as shown earlier and is complete, the movement of the prices is in the opposite direction. The abundant factor becomes cheaper after trade instead of becoming dearer, and the scarce factor becomes more expensive after trade instead of becoming cheaper. We have already seen in the last chapter that as far as the Heckscher-Ohlin theorem is concerned, the trade result does not follow unless we assume the tastes to be the same and the income elasticities of demand to be unitary in both the countries (Chapter III, pp. 46,47). However, the Heckscher-Ohlin corollary of factor price equalisation follows even with divergent tastes, although the process is exactly opposite of that outlined in the beginning of this chapter.

In the preceding analysis it was assumed that after trade each country produces something of both goods. In other words, the points such as M , M' and N , N' in figure 12B lie inside the boxes

OL'O'C and OLO"C" , respectively, and neither of the two countries specializes completely in the production of either good. As seen earlier (Chapter III, pp. 42, 43) it is possible that there are points on the contract curve of either country which have no corresponding points in the other country. Consider figures 13A and 13B[1], where the points on the segment M'O' on country I's contract curve in figure 13A have no corresponding points on country II's contract curve in figure 13B. Similarly, the points on the segment N'O of country II's contract curve in figure 13B have no corresponding points on country I's contract curve in figure 13A. Factor prices at M' in country I and O" in country II are the same, as the slopes of the tangents at these points are the same. Similarly, factor prices at N' in country II are the same as at O in country I for the same reason.

What will happen to factor prices in case the trade equilibrium occurred at some point on the segment M'O' on country I's contract curve or at some point on the segment N'O on country II's contract curve? If it occurs at a point on segment M'O' on country I's contract curve, country II will be at point O" . At this point country II specializes completely in the production of commodity A and produces nothing of commodity B . The factor price ratio at this point corresponds to that of point M' in country I. But country I's equilibrium trade point is on the M'O' segment where the slope of any tangent would be steeper than at M'. Thus, the relative price of labour is higher at any point of segment M'O' than at M' or O" . If trade equilibrium

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[1] K. Lancaster, op. cit., p. 29.

Country I

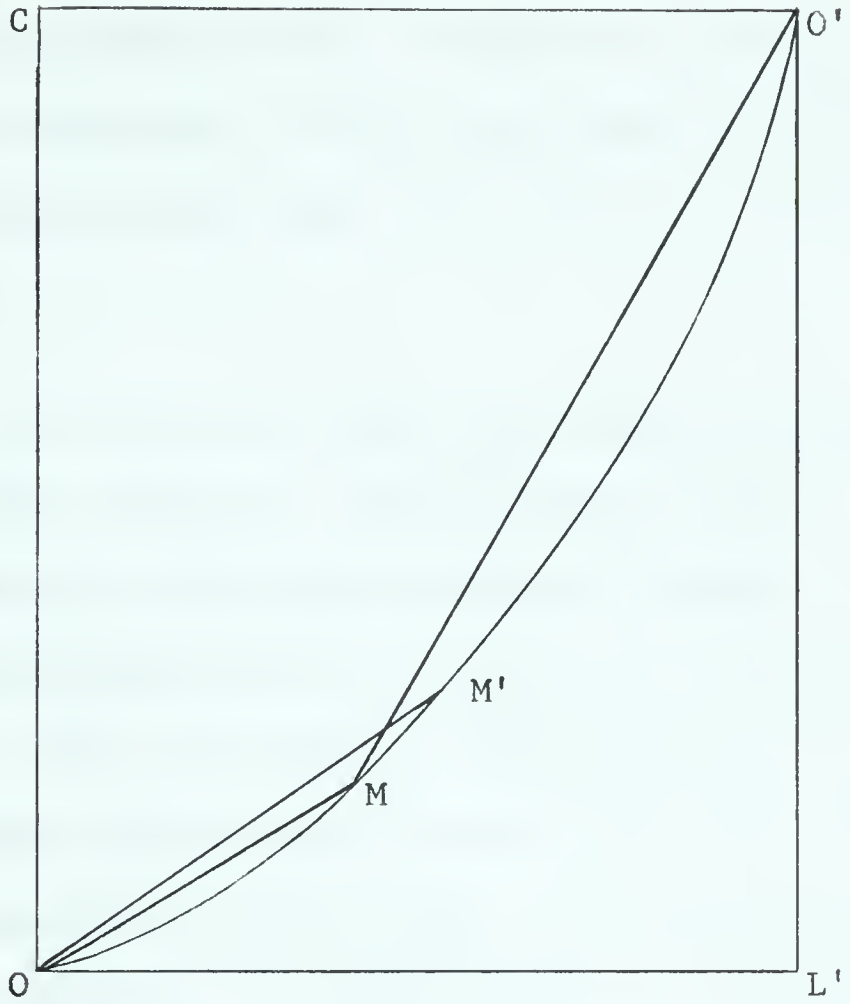

Figure 13A

Country II

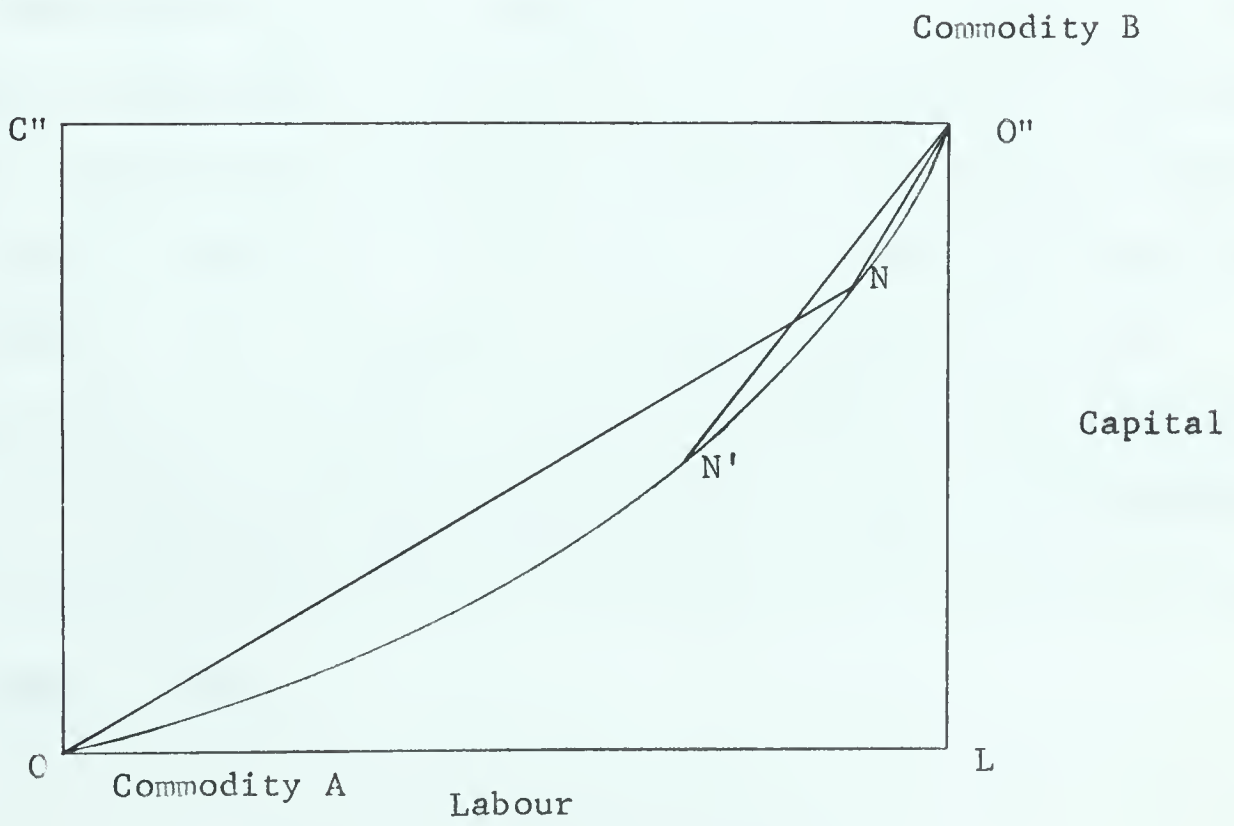

Figure 13B

occurs at any point on M'O' , the factor prices will not be equalised in the two countries. In this case, there is more demand for commodity A than can be met by country II, even if it produces nothing but commodity A .

As country I is relatively capital abundant, any point on segment M'O' represents a higher ratio of capital to labour in both the industries and a lower relative price of capital. If country II specialises completely the relative price of capital will be lower in country I. Thus with complete specialization by one country, the return to the other country's more abundant factor will be lower and the return of its less abundant factor higher than in the completely specialized country.[1] Similarly, if trade results in a situation where country II is at any point along N'O , country I will be at point O where it specialises completely in the production of B and produces nothing of commodity A . The factor price ratio at point O in country I corresponds to that at point N' in country II. The slope of the tangent at any point on the N'O segment of country II's contract curve is less steep than that of the tangent at point O in country I. Since more labour is equivalent in value to a unit of capital at a less steep slope, the relative price of capital is higher at any point on segment N'O in country I than at N' or O. Thus, if trade equilibrium occurs at any point on N'O in country II the factor prices will not be equalised in the two countries. In this case there is more demand for commodity B than can be supplied by country I, even if it completely

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[1] Ibid., p. 30.

specialises in producing that commodity. Any point on segment N'O in country II represents a higher ratio of labour to capital, in both the industries, than at N'. This implies a lower marginal productivity of labour and a lower relative price of labour than that in country I.

We may note here that the Heckscher-Ohlin theorem follows immediately if one country specialises completely in the production of one commodity. Not only does that country have a comparative advantage in the production of the commodity intensive in its abundant factor, but it produces only that commodity and nothing else of the other. It follows that it must export that commodity when trade takes place. However the Heckscher-Ohlin corollary of factor price equalisation does not follow with complete specialisation in production by either country. If factor price equalisation is to take place both countries have to continue producing both commodities after the opening up of trade between them.

What will happen to factor prices if an unequivocal definition of factor intensity is not possible? As we have already seen in the last chapter (figure 9) even if the isoquants intersect twice (the same commodity, in other words, is labour intensive at one set of factor prices and is capital intensive at another) as long as factor proportions in the two countries are on the same side of OS (in figure 14) the earlier analysis about the trade pattern will apply in full in both the countries. The factor price equalisation corollary will also follow, in this case subject to the restriction mentioned earlier that no country specialises completely in the production of one commodity.

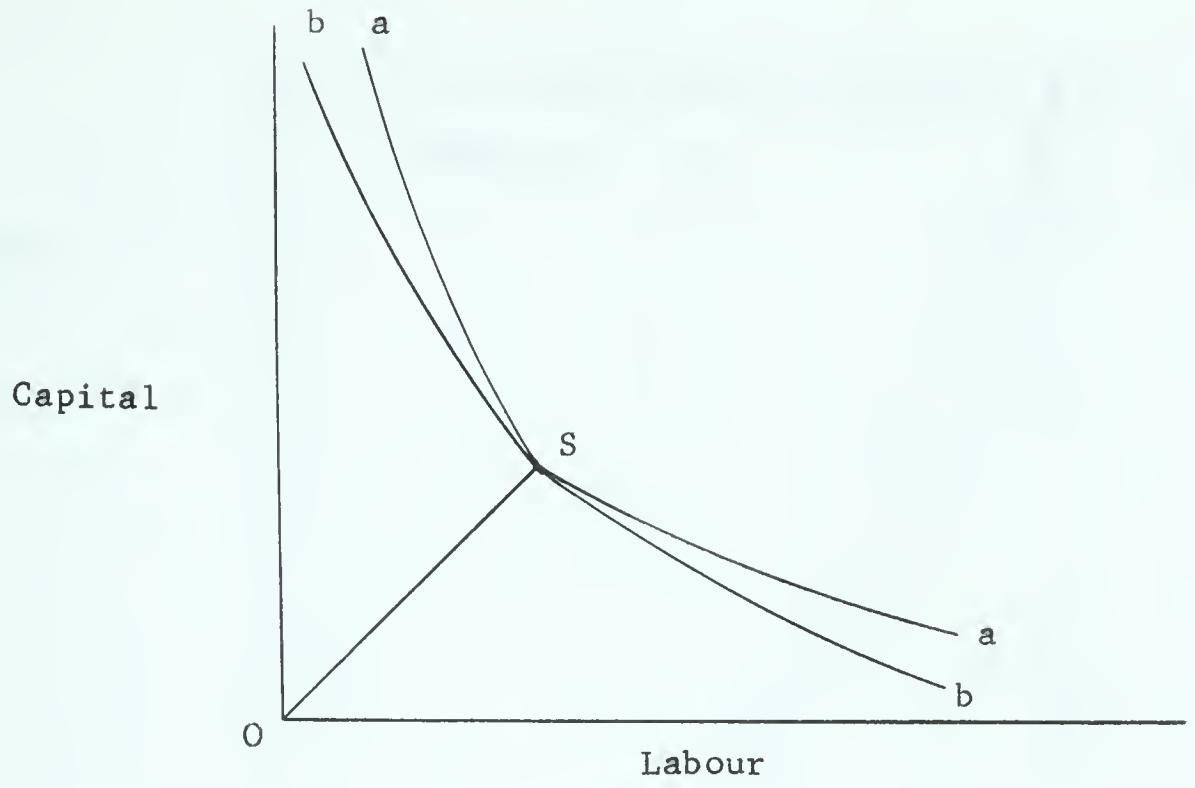

Figure 14

But if factor proportions in the two countries lie on opposite sides of OS , modifications are necessary in the previous analysis since the same commodity will now be labour intensive in one country and capital intensive in another. In this case the situation will be as shown in figures 15A and 15B.[1] In the capital abundant country I, commodity A is labour intensive and commodity B is capital intensive, so that the contract curve lies below the diagonal since labour is represented on the horizontal axis and the labour intensive commodity A's origin is O.

However, in the labour abundant country II the same commodity A is capital intensive and commodity B labour intensive, so that the contract curve lies above the diagonal since labour is represented here also on the horizontal axis, capital on the vertical; and the origin for commodity A is at O' , and that for commodity B at Q'.

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[1] These figures are taken from K. Lancaster, Ibid., p. 37.

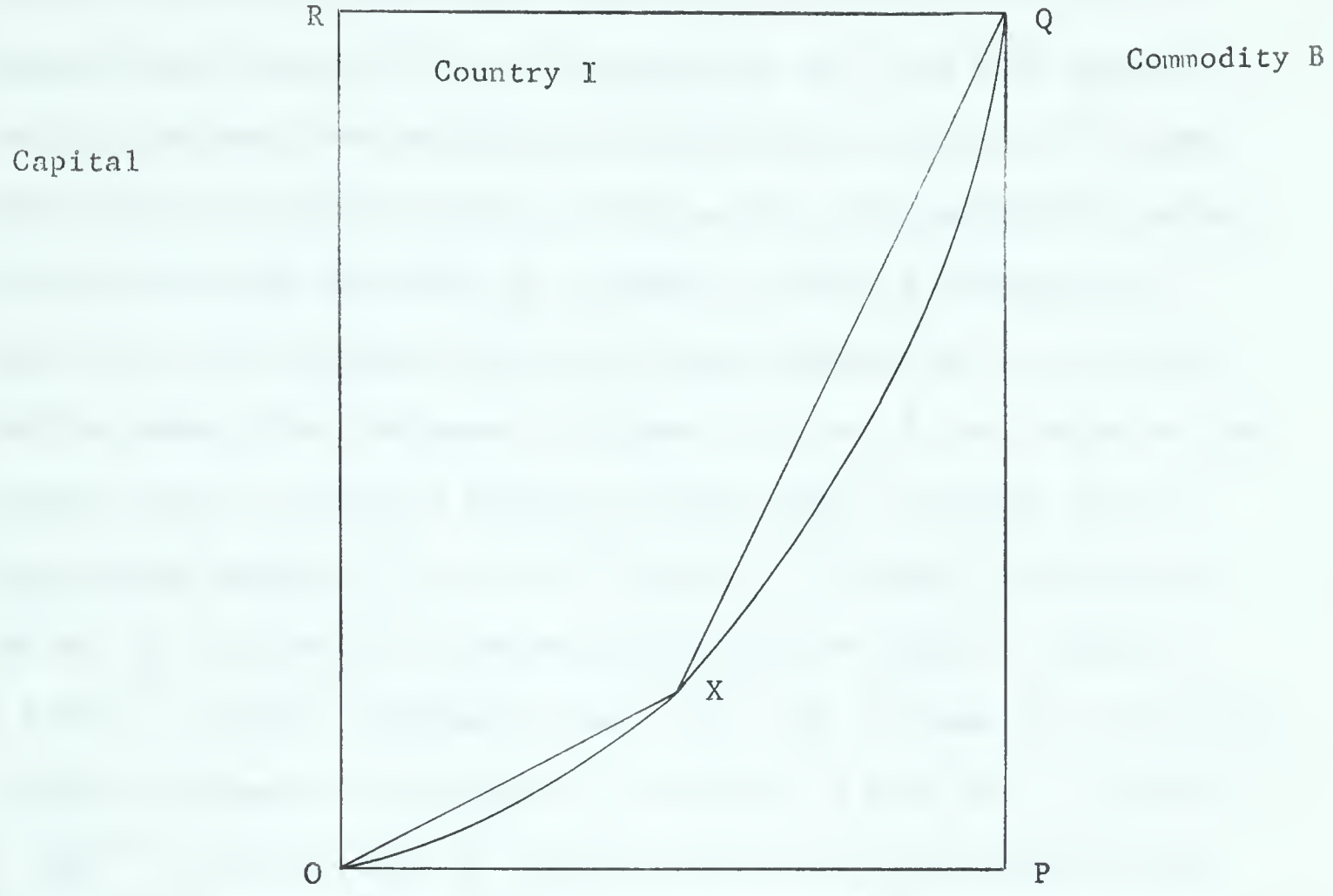

Figure 15A

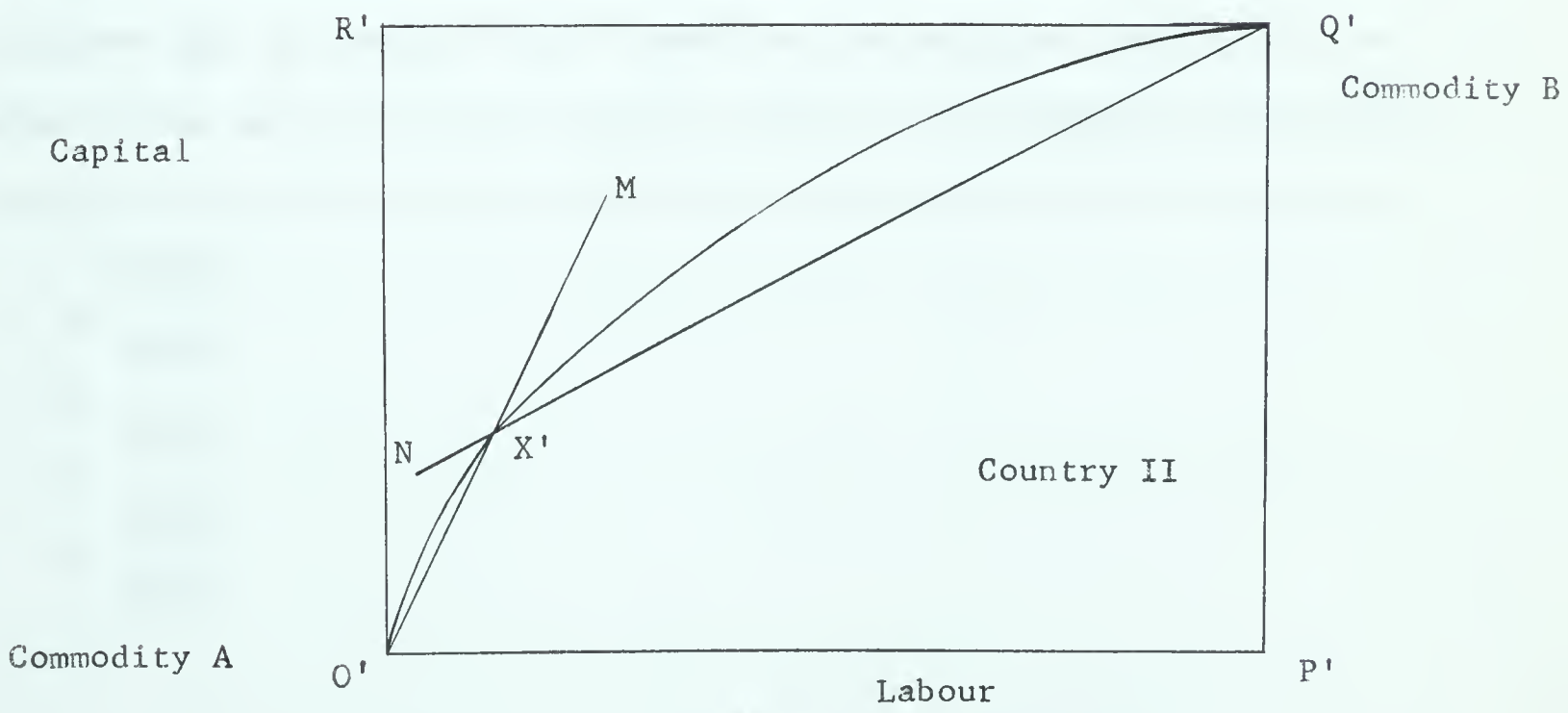

Figure 15B

(Country I's factor proportions lie above or to the left of OS in diagram 14 and country II's, to the right of OS.) We have assumed that the isoquants are perfectly symmetrical about the ray OS along which they are tangent (as shown in figure 14). By appropriate choice of the scale along one axis, OS is made to lie at a 45° angle to either axis. The contract lines in figures 15A and 15B are derived from the symmetrical isoquants in figure 14. Let X be a point on the contract line of country I (shown in figure 15A).[1] Draw in the box representing country II a ray O'M through O' which is inverse to the ray OX in country I (represented by the box OPQR).[2] That is, $\angle$ R'O'M = $\angle$ POX.[3] Similarly draw a ray Q'N through Q' in country II which is inverse to the ray QX in country I such that $\angle$R'Q'N = $\angle$ PQX.[4] Then the point X' which lies at the intersection of the rays O'M and Q'N is the inverse point to the point X in country I.[5]

The isoquants are symmetrical about the 45° tangent ray. The angle between one ray and one axis for one country (say OX and OP in figure 15A in country I) is equal to the angle between the inverse of that ray and the other axis for the other country (say O'M and O'R' in figure 15B in country II). Therefore, the marginal productivity of labour along any ray in one country is equal to the marginal productivity

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1 Ibid.

2 Ibid.

3 Ibid.

4 Ibid.

5 Ibid.

of capital along the inverse of that ray in the other country. In diagrams 15A and 15B, the rays O'M and Q'N in country II are the inverses of the rays OX and QX respectively in country I. Therefore the marginal productivity of labour in the production of both the commodities at point X' in country II is equal to the marginal productivity of capital in the production of both commodities at point X in country I.[1]

Let $L'A_1$ and $L'A_2$ denote the marginal productivities of labour in the production of A in the two countries respectively and $C'A_1$ and $C'A_2$ denote the marginal productivities of capital in the production of commodity A in the two countries respectively. Similarly, let $L'B_1$ and $L'B_2$ and $C'B_1$ and $C'B_2$ denote the marginal productivities of labour and capital in the production of commodity B in the two countries. Then our above conclusion, expressed symbolically, for points X and X' is:

$$C'A_1/C'B_1 = L'A_2/L'B_2 \quad \ldots\ldots \quad I$$

The commodity price ratio in country I at X is given by $L'A_1/L'B_1$ and that at X' in country II is given by $L'A_2/L'B_2$. Since X is on the contract curve of country I, the ratio of the marginal productivities of labour in the two commodities, A and B, is equal to the ratio of the marginal productivities of capital in A and B.

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[1] Ibid.

Symbolically,

$$L'A_1/L'B_1 = C'A_1/C'B_1 \quad \ldots\ldots \quad II$$

and, following from equation I, the latter ratio is equal to $L'A_2/L'B_2$. Hence,

$$L'A_1/L'B_1 = L'A_2/L'B_2 \quad \ldots\ldots \quad III\ .$$

As shown earlier, the left side gives the commodity price ratio in country I and the right side gives that of country II. Hence the commodity price ratio at X in country I is the same as that at X' in country II. Hence X and X' are a possible pair of free-trade points in the two countries.

What will be the pattern of trade in this case? The general rule, according to Lancaster, is the following: "Country II will export that good which is intensive in the factor relatively abundant in comparison with the inverse of country I".[1]

Country I in our case, although a capital abundant country, exports its labour intensive commodity A to country II in exchange for commodity B . Suppose, the capital/labour endowment ratio in country I is, 7:6 and that in country II is 5:8. The inverse of the capital/labour ratio in country I is 6:7 which is greater than 5:8, the capital/labour ratio of country II. Country II is thus relatively labour abundant in comparison with the inverse of the ratio of

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[1] Ibid., p. 39.

factor endowment of country I. So country II will export her labour intensive commodity B and import commodity A from country I, although A is labour intensive in country I and country I is capital abundant.

If, however, the capital/labour ratio in country I were 3:1 and the ratio in country II were 1:2, the inverse of country I's capital/labour ratio, 1:3 , would be less than the capital/labour ratio of 1:2 of country II. Country II in that case would export its capital intensive commodity A in spite of being a labour abundant country. It would import commodity B from country I, this commodity being relatively capital intensive in that (capital abundant) country.

The pattern of trade outlined above is, of course, subject to the condition that demand is the same in the two countries and that both have unit income elasticities of demand. This pattern of trade goes against the Heckscher-Ohlin theorem.

What will happen to factor prices in this case where factor intensities are reversed between the countries? Referring to figure 14, the factor endowment ratio of country I is to the left of OS and that for country II is to the right of OS. As the tangent at any point on the A or B isoquants, aa and bb , to the left of OS will have steeper slope than that at any point to the right of OS , capital is relatively cheaper in the capital abundant country I, regardless of demand conditions. Similarly, labour will be relatively cheaper in country II. It follows that whatever the post-trade commodity price ratio, factor prices will never be equated.

CHAPTER V

THE LEONTIEF PARADOX

Before examining the empirical findings on the Heckscher-Ohlin theory, a word about the generalisation of the Heckscher-Ohlin model is in order. The generalisation of this two-country, two-commodity and two-factor model is essential for empirical testing as the real world is a multi-country, multi-commodity and multi-factor world. The theoretical model, unless generalised, is not amenable to empirical testing.

Let us suppose to begin with that there are many countries, but only two factors and two commodities. The analytical framework outlined in the earlier chapters can be applied to derive their contract and transformation curves and finally, given the demand conditions, to derive their commodity prices.[1]

However, there are several alternative versions of the Heckscher-Ohlin hypothesis that are possible in a multi-country framework. The comparison of factor endowments may be (1) between country I and the sum of all the other countries of the world, or (2) between country I and the sum of all the countries directly in trade with it, or (3) between country I and the sum of all the countries directly or indirectly in trade with it, or (4) between country I and each of the countries in direct trade with it, so that the Heckscher-Ohlin hypothesis would hold for each pair of countries bilaterally.[2] There is little in

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[1] S. Mookerji, op. cit., p. 59.

[2] J. Bhagwati, "The Pure Theory of International Trade: A Survey", The Economic Journal, LXXIV (March, 1964), p. 20.

the traditional analysis of the Heckscher-Ohlin hypothesis which affords a reliable clue to a meaningful choice among these different ways in which the hypothesis can be interpreted in a multi-country framework.[1] "Nor need we expect the conditions under which each of these hypotheses will be logically true to be identical either with each other or with those that have been spelled out for the restrictive traditional frameworks."[2]

"If there are more than two commodities, we can list the commodities in an ascending or descending order of capital-labour ratios employed in production and thus rank them in order of comparative advantage in production."[3] If our starting point is a difference in relative factor prices, then demand conditions will merely determine the dividing line between exports and imports without in any way disturbing the ranking in terms of factor intensity.[4] If on the other hand, we start from a difference in factor endowment proportions, then difference in comparative advantage in production may or may not be reflected, as before, in relative commodity prices.[5] In other words, the ordering of commodities according to their prices which will determine the trade pattern may or may not conform to their ordering according to factor intensity.[6] If we have more than two factors and more than two commodities, consistent ordering of the commodities by factor intensity involves

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1 Ibid.

2 Ibid.

3 S. Mookerji, loc. cit.

4 Ibid.

5 Ibid., pp. 59, 60.

6 Ibid., p. 60.

restrictive conditions. Consistent factor intensity implies that every factor can be associated with a single good in respect of which it is particularly important.[1] If we have three commodities A, B and C intensive respectively in the three factors X, Y and Z, then

X_A/Y_A	is	greater	than	both	X_B/Y_B	and	X_C/Y_C
X_A/Z_A	"	"	"	"	X_B/Z_B	"	X_C/Z_C
Y_B/X_B	"	"	"	"	Y_A/X_A	"	Y_C/X_C
Y_B/Z_B	"	"	"	"	Y_A/Z_A	"	Y_C/Z_C
Z_C/X_C	"	"	"	"	Z_A/X_A	"	Z_B/X_B
Z_C/Y_C	"	"	"	"	Z_A/Y_A	"	Z_B/Y_B

where X_A/Y_A refers to the proportion of X and Y employed in A, X_B/Y_B to the proportion X and Y employed in B, and so forth.[2] As the number of factors and commodities further increases, the conditions become more numerous and more restrictive.[3] It is clear from the foregoing analysis that the simple geometrical model is not capable of handling the multi-country, multi-commodity, multi-factor generalized model, for the concepts of factor intensity and factor abundance lose their clarity and simplicity.

Empirical testing of the Heckscher-Ohlin model has been undertaken by Leontief for the United States, Bharadwaj for India, Tatemoto and Ichimura for Japan and Wahl for Canada. It is not possible to

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1 Ibid.

2 Ibid.

3 Ibid.

consider all of them in the limited space of this chapter. We will therefore examine Leontief's investigation more fully and just mention the results arrived at by the others. There is no discussion in any of the investigations mentioned above of the alternative interpretations of the Heckscher-Ohlin hypothesis but the majority of them (with the glaring exception of Leontief) have implicity adopted the bilateral interpretation.

Leontief published in 1953 his "first preliminary progress report of a study designed to analyse the structural basis of trade relationships between the United States and the rest of the world".[1] It is typical of his contribution that, while factor intensities are carefully ascertained, the factor abundance of the country in question is left uninvestigated.[2] He starts with the oft repeated common sense argument that as the United States possesses a relatively large amount of capital and small amount of labour, she has a comparative advantage in capital intensive commodities.[3] He uses the 1947 input-output structure of the American economy as the basis of his computations. He finds the capital and labour input requirements for producing an additional million dollars worth of output. These requirements - which

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[1] W. Leontief, "Domestic Production and Foreign Trade: the American Capital Position Re-examined", Proceedings of the American Philosophical Society, XCVII (September, 1953), pp. 332-49. Reprinted in Economia Internazionale, VII (February, 1954), p. 11.

[2] J. Bhagwati, op. cit., p. 21.

[3] W. Leontief, op. cit., pp. 10, 11.

are called the direct requirements - are only a part of the total capital and labour requirements. The indirect requirements - the capital and labour input needed by other sectors so that this additional million dollars worth of output can be produced - together with the direct requirements constitute the total capital and labour requirements. These indirect requirements are also computed from the input output table.

Leontief then imagines a situation in which the United States decides to decrease both its imports and exports by one million dollars each.[1] He examines the case in which this reduction is to be achieved by an equal proportional cut in each export and import commodity, so that the composition of exports and imports remains the same. The only difference between the treatment of imports and exports here results from the fact that some imports such as tea, coffee and jute which cannot be produced in the United States - the non-competitive imports - are assumed to remain constant. The domestic production of import-competitive goods would have to expand by amounts equal to the reduction in the corresponding imports, i.e., by the same proportional amounts. For the computation of the direct and indirect requirements of labour and capital for the import replacements, the same 1947 input:output structure of the economy is used. The actual composition of trade in 1947 is taken as the basis for calculating the reduction in exports and the increment in import replacement industries.

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[1] S. Mookerji, op. cit., p. 75.

The principal findings of the quantitative analysis are summarized in the following figures:[1]

Domestic Capital and Labour Requirements per Million Dollars of United States Exports and of Competitive Import Replacements

(of Average 1947 Composition)

	Exports	Import Replacements
Capital (dollars, in 1947 prices)	$2,550,780	$3,091,339
Labour (man years)	182.313	170.004

These figures show that an average million dollars' worth of United States exports embodies considerably less capital and somewhat more labour than would be required to replace from domestic production an equivalent amount of the United States competitive imports.[2] Thus, the United States apparently specialises in labour intensive rather than capital intensive lines of production.[3] This is contrary to the commonly held view. Leontief concludes that the United States economy is characterised by a relative plenty of labour.

He explains this unexpected result by the superiority of the American labour. If in any combination with a given quantity of capital, one man year of American labour is equivalent to, say, three man years of foreign labour, the number of American workers should be multiplied by three to arrive at the labour force of the United States for the sake

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1 W. Leontief, op. cit., p. 24.

2 Ibid., pp. 24, 25.

3 S. Mookerji, loc. cit.

of comparing the relative factor endowments of the United States with the rest of the world. When the capital supply of the United States is spread thrice as thinly as the unadjusted figures, it turns out to be comparatively smaller, rather than larger, than that of many other countries. He hesitates to comment on the reasons for this higher productivity of the American worker. However, he makes the negative observation that this higher productivity cannot be explained by the large amount of capital used per worker. If capital can be substituted for labour in the United States, so can it be elsewhere with the same effect. He points to entrepreneurship, superior organization and favourable environment as the possible reasons for higher productivity of the American worker.[1] Thus, although the United States has more capital per worker than the other countries, if the supply of labour is expressed in "efficiency units" the United States will be found to be relatively rich in manpower and poor in capital - a conclusion in keeping with both the empirical finding and the Heckscher-Ohlin theory.[2]

In his first report, Leontief states:

> Invisible in all these tables but ever present as a third factor or rather as a whole additional set of factors determining this country's productive capacity and, in particular, its comparative advantage vis-a-vis the rest of the world, are the natural resources: agricultural lands, forests, rivers and our rich mineral deposits.[3]

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[1] W. Leontief, op. cit., p. 28.

[2] S. Mookerji, op. cit., p. 76.

[3] W. Leontief, op. cit., p. 35.

In the second report, greater attention is paid to this matter where he notes that it is impracticable to include these natural resources explicitly due to the absence of comprehensive statistical information concerning their supply and utilisation.[1] In the absence of the explicit inclusion of the third factors in the calculations, the relative factor intensities do not mean the same thing.[2] For example, imports may require more capital per unit of labour than exports; it is nevertheless possible that imports are intensive in a third factor, say, land and not in capital.[3] Where substitution between factors is possible, the higher capital to labour ratio in the import-competing industries in a given situation may be due to the fact that capital is a better substitute for land than is labour.[4] With many factors, some of which are qualitatively incommensurable as between different countries, the assumption of identical production functions becomes difficult to maintain.[5]

Ellsworth maintains that the Heckscher-Ohlin theory can be applied only if the foreign capital-labour ratio for actual production of United States imports (and not the capital-labour ratio prevailing

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[1] W. Leontief, "Factor Proportions and the Structure of American Trade: Further Theoretical and Empirical Analysis", Review of Economics and Statistics, XXXVIII (November, 1956), p. 395.

[2] S. Mookerji, op. cit., p. 82.

[3] Ibid.

[4] Ibid.

[5] Ibid.

in the United States for import substitutes) is compared with the capital-labour ratio in U.S. export production.[1] If this were done, then the Leontief paradox, he believes, will disappear.[2] In his view, relatively more capital is used in the manufacture of import replacements in the United States in order to compete effectively with goods produced abroad by relatively cheap labour.[3] This implies that either the production functions in the United States and abroad are different or that, given identical production functions, the relative factor endowments are such that the factor intensities reverse themselves.[4] In either case, the Heckscher-Ohlin theory would not be applicable.[5]

Leontief's procedure of defining labour in "standard" or "efficiency" units is not persuasive because it already assumes that the Heckscher-Ohlin theorem provides a valid explanation of the American pattern of trade when, in fact, the question being asked is precisely whether it does.[6] As Valavanis has pointed out, it is surprising that Leontief starts to re-examine the factor endowments of the United States. Usually the unexpected empirical findings lead to a re-examination of the theory.[7]

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[1] P. T. Ellsworth, "The Structure of American Foreign Trade: A New View Examined", Review of Economics and Statistics, XXXVI (August, 1954), pp. 280-81.

[2] Ibid.

[3] Ibid.

[4] S. Mookerji, op. cit., p. 83.

[5] Ibid.

[6] J. Bhagwati, op. cit., p. 24.

[7] S. Valavanis, "Leontief's Scarce Factor Paradox", Journal of Political Economy, LXII (December, 1954), p. 523.

As seen in the earlier chapters a country does not have to export the products of its most abundant factor. Therefore, although American labour may, in fact, be superior to foreign labour, this is not a sufficient explanation of the pattern of trade that Leontief observes.[1] Similarly, as examined in the earlier chapters, a country does not have to produce relatively more of the product of its abundant factor.

Swerling points out that the year 1947 selected for empirical testing by Leontief was not a typical year as far as trade is concerned for two reasons. First, in 1947 the dollar value of United States exports was close to three times the dollar value of imports.[2] One effect of conversion to a proportional basis is the pre-eminent position of agriculture and fisheries on the import side in the statistical calculations, even though the sector enjoyed a net export surplus in absolute terms.[3] Second, by 1947 the post-war disorganisation of production overseas had not yet been corrected.[4] The quantum of exports from Europe was still one third below and that from North America considerably more than a hundred percent above the pre-war level.[5] Close to half of the United States exports were financed by grants and credits under various foreign aid programmes.[6]

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1 Ibid.

2 B. C. Swerling, "Capital Shortage and Labour Surplus in the U.S.?" Review of Economics and Statistics, XXXVI (August, 1954), pp. 286-87.

3 Ibid.

4 Ibid. p. 288.

5 Ibid.

6 Ibid.

The overriding importance of agriculture and fisheries on the import side biased upward the capital intensity of imports.[1] For most sectors where the trade deficit or surplus was seen to be large, available natural resources are so important that the specific significance of capital-labour requirements tends to be largely obliterated.[2] This is especially true of the following groups of imports: Agriculture and Fisheries products, Paper and Paper Board, Rubber, Pulp Mill products, other Nonferrous Metals, and Crude Petroleum.[3] The direction as well as the composition of United States foreign trade reflects obvious advantages and disadvantages in America's natural resources as compared with those elsewhere.[4] Perhaps, the generalization most clearly supported by Leontief's exploratory study is that world trading relationships depend to a greater degree on the unequal distribution of natural resources than on comparative endowments of capital and labour.[5]

Before turning to the other empirical investigations of the Heckscher-Ohlin theory, the thing that obviously strikes one's mind about Leontief's investigation is the fact that the factor endowments of the United States are left uninvestigated. If the capital:labour

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[1] Ibid., p. 287. Quite contrary to the general notion, agriculture is capital intensive due to mechanized farming in the United States, although it might not be so in a country like India.

[2] Ibid., p. 289.

[3] Ibid.

[4] Ibid.

[5] Ibid.

ratio in the United States vis-a-vis some other country is high, then in spite of the results of the investigation, the United States is capital rich. It surprises one to find that instead of investigating the factor endowments first and then examining the trade results to test the Heckscher-Ohlin theory, the process is exactly reversed. As the results of the investigation go against the Heckscher-Ohlin theory, the United States factor endowments are redefined to suit the theory.

Now, to turn to the results of some of the other investigations in the field without going into details. Tatemoto and Ichimura arrived at the results that for Japan, exports are capital-intensive and imports are labour-intensive.[1] This result again seems to contradict the Heckscher-Ohlin hypothesis.[2] For East Germany, exports were found capital-intensive and imports labour-intensive. The authors of that study, Stolper and Roskamp, found this consistent with the stated hypothesis.[3] For Canada, Wahl found that the exports were capital-intensive and imports were labour-intensive. This was an unsuccessful verification, as Canadian trade is primarily United States oriented.[4]

Where many of these studies innovate is in departing from the Leontief method of taking the aggregate exports and competitive imports.[5]

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[1] J. Bhagwati, op. cit., p. 25.

[2] Ibid.

[3] Ibid.

[4] Ibid.

[5] Ibid.

They begin to explore the possibility of defining the Heckscher-Ohlin hypothesis in the bilateral form (i.e., for each pair of countries) rather than in terms of one country and (presumably) the rest of the world.[1] Thus, Bharadwaj goes on from the aggregative analysis to work out the factor-intensities of Indian trade with the United States, Wahl works with Canada - United States and Canada - United Kingdom trade, and the Tatemoto - Ichimura result is interpreted in terms of the geographic composition of Japanese trade.[2]

In the Indian case, when Indo - United States trade is isolated for analysis, the factor intensities are the reverse of those that obtain for total Indian trade.[3] Indian exports to the United States turn out to be capital-intensitve and the imports from the United States labour-intensive, thus appearing to refute the Heckscher-Ohlin hypothesis.[4] For Canada, the bilateral results are identical with the aggregate results and refutation continues.[5] For Japan, however, the result of disaggregation is beneficial.[6] In the Japanese case, the aggregative result is supposed to be attributable to the fact that 75 per cent of Japanese exports go to the (presumably labour-abundant)

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1 Ibid.

2 Ibid.

3 Ibid.

4 Ibid.

5 Ibid.

6 Ibid.

underdeveloped areas and only 25 per cent to the (presumably capital-abundant) advanced countries.[1] It is widely accepted in Japan that the Japanese economy is somewhere between the advanced and underdeveloped countries, and the "disaggregated" explanation is only a logical consequence.[2] Tatemoto and Ichimura have computed the capital-labour ratios of Japanese exports to the United States and of imports from the United States and find the latter higher than the former.[3] Unlike the Indian case, therefore, a disaggregated approach supports the Heckscher-Ohlin approach in the Japanese study.[4] The Japanese result thus demonstrates the possibility of profitably adapting the Heckscher-Ohlin hypothesis so as to state it in terms of each pair of trading countries (instead of in aggregate terms as Leontief has done).[5] When the diverse bits of information are put together, it is difficult to conclude as to the direction of the evidence.

The most interesting recent result has been Minhas' demonstration that, far from being a theoretical curiosum (as Samuelson believed it to be), the reversal of factor intensity is an empirical possibility of some significance.[6] Since his data relate to the United States and Japan, the results appear to furnish additional ammunition to those who are akeptical of the utility of the Heckscher-Ohlin approach.[7]

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1 Ibid.

2 Ibid.

3 Ibid.

4 Ibid.

5 Ibid.

6 Ibid., p. 26.

7 Ibid.

CHAPTER VI

CONCLUSION

The Heckscher-Ohlin theory in its modern version is often branded as narrow and restrictive in its scope. But as we have examined in Chapter II, this criticism does not apply to the theory as developed originally by Heckscher and Ohlin themselves. Ohlin realised that, even ignoring dynamic considerations, differences in quality between factors of production, different technological processes, the economics of large scale production, differences in social institutions and atmosphere, fiscal policy and transport costs might substantially modify the conclusions derived from the abstract model.[1]

The importance of these factors was analyzed by him at length with numerous illustrations from economic experience of various countries.[2] These various factors do not fit neatly into a systematic theoretical pattern.[3] As our assumptions approach reality more closely, the theoretical formulation tends to become more imprecise and conclusions less certain.[4] A precise formulation has to rest on assumptions which are highly restrictive and often unverifiable.[5] Thus, on either count, criticism is inevitable. In its original form, Ohlin's theory is

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1 B. Ohlin, op. cit., p. 113.

2 S. Mookerji, op. cit., p. 84.

3 Ibid.

4 Ibid.

5 Ibid.

realistic, but imprecise and uncertain in its conclusion. It lacks the logical body of a theory and merely emphasizes factor endowments as the most important of all the forces that lead to trade.

In its recent version, the theory achieves logical perfection (in the hands of Samuelson and others), but the assumptions become highly restrictive. This leads to innumerable difficulties when we start testing the theory empirically, as was seen in the last chapter. At the extreme, a logically perfect theory can be unverifiable and useless for the purposes of practical application.

It is a dilemma. What can we say, then, about the two versions of the Heckscher-Ohlin theory? Can we conclude that each version has its own merits and demerits? One way to answer this question would be in the negative, and to emphasize that the accent should be (as is the trend today) on the development of pure theory for its own sake, in every branch of the sciences. We should stress the logical perfection of a theory irrespective of the unrealistic nature of the assumptions or its usefulness in practical application. We could in this case conclude that it is better to have a useless theory than to have no theory at all. It is possible to modify the logical structure or to introduce additional assumptions in that structure to make the theory useful and applicable in practice. One is sure then that there are no loopholes in the logical structure of the theory and, therefore, no drawbacks or doubts on that count if this modified theory is applied to practical problems. As this is the virtue of the recent version of the Heckscher-Ohlin theory, we should strive for perfection. When we consider

Ohlin's original version of the theory in this light it is evident that it tries to be too general (by taking into account all the relevant factors) to be a good theory.

However, this is only one side of the problem at hand. Practical economic problems and economic theory feed and depend upon each other. Ohlin as an empirical scholar provides a necessary link between actual economic situations and economic theory and, as such, his theory deserves all the merit. His theory might have suffered in precision but one can also argue that an imperfect theory can (even if not necessarily every time) be perfected. It is evident that no hasty conclusions are necessary or useful about the two versions of the Heckscher-Ohlin theory.

Lancaster interprets the recent version of the Heckscher-Ohlin theory in such a way that its restrictive scope becomes a virtue rather than a drawback.[1] The recent version of the theory points out the minimum difference essential for countries to trade with each other. The theory also answers the question of the future of international trade. Even if due to faster, easier and cheaper communications technical advances are made available to all the countries of the world, trade among them would continue as long as their factor endowments are different. It is also natural that due to increased communications among countries, the differences in tastes will be narrowed and might even disappear completely. By explicitly assuming the same tastes and

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[1] K. Lancaster, op. cit., pp. 20, 21.

the same production functions between the two countries the Heckscher-Ohlin theory shows that trade can exist under these conditions if factor endowments differ between countries.

Thus, the restrictive scope of this theory is not in assuming away the differences in tastes or technology. It is in the lack of a generalized theoretical model. It is essential to generalize this two-country, two-commodity, two-factor model to a multi-country, multi-commodity, and multi-factor model and to bring out explicitly the necessary and sufficient conditions for trade to exist for this generalized model. It will then be much easier to test it empirically.

James and Pearce have criticised the assumptions of identical production functions and of constant returns to scale as "unrealistic" and very specialised in their nature.[1] As already seen above, when we try to find out the minimum difference between countries sufficient to explain the existence of trade, the assumption of identical production functions eliminates differences in knowledge and technique, and the assumption of constant returns to scale eliminates the difference in size, so that only one difference remains, a difference in proportions between qualitatively identical factors.[2] Once the matter is seen in this light, as a problem of determining the minimum difference necessary

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[1] S. F. James and I. F. Pearce, "The Factor Price Equalisation Myth", The Review of Economic Studies, XIX (No. 2, 1952), pp. 111-22.

[2] K. Lancaster, loc. cit.

for trade, the apparent vices of the Heckscher-Ohlin model are seen to be virtues.[1]

Ricardian theory found the reason for trade in differences in skills and/or techniques of production between the countries. In that case international trade would cease to exist in future, as Portugal could learn to make cloth as cheaply as England. This would not eliminate trade in the Heckscher-Ohlin model.

However, the most important contribution of this model to the theory of trade has been its satisfactory integration (for the first time) of factor markets with commodity markets. Much of its impact has been in this field. Ricardian theory consisted merely of propositions about the relative prices of commodities. This theory added a series of propositions about the relative prices of factors. The question of "factor price equalisation" has far reaching implications about factor movements. Factor movements are seen in the light of this theory (wherever applicable) to be superfluous in achieving equal factor returns around the world. This result is of importance for policy toward factor movements.

In essence, the integration of factor markets makes this theory more complete and more sound in its foundations. The Heckscher-Ohlin theory, therefore, deserves a place at the centre of international trade theory.[2] It is, in fact, the simple model of international trade

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[1] Ibid.

[2] Ibid., p. 21.

when things are reduced to the most elemental terms (not necessarily the most elementary terms), just as the two-commodity indifference curve is the elemental model of consumer behaviour.[1]

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[1] Ibid.

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